May 1993 Issue #22

Radio Fu

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"The beginner's guide to the exciting world of amateur radio."

in this issue

features

vintage review

departments

Protection for the Ham Bands?

Congress has come another step closer to protecting amateur radio in any final reallocation of government spectrum to commercial use. On March 2nd, the US House of Representatives adopted House bill H.R. 707, the "Emerging Telecommunications Technologies Act of 1993." The legislation had been reported out, without amendment, by the House Committee on Energy and Commerce.

The strong pro-amateur-radio position taken by the Committee is thanks in large part to the intervention of Representative Mike Kreidler of the 9th Congressional District in Washington. Kreidler raised the concerns of radio amateurs during a mark-up session on February 16th. His pro-ham-radio comments so impressed Committee Chairman John Dingell that Dingell indicated his support for ham operators and his willingness to address these issues in the mark-up process.

The bill requires the federal government to release 200 MHz of frequency spectrum for commercial use to foster new technologies in the private sector, with at least 180 MHz to be below 5 GHz. It is virtually identical to legislation that was adopted by the House in 1991, but that did not make its way through the Senate during the 102nd Congress.

In recommending adoption, the Committee report said, "An example of the dilemma that spectrum managers must face due to spectrum congestion was provided several years ago, when the Commission was forced to reallocate 2 MHz of spectrum that had been utilized, on a secondary basis, by the Amateur Radio Service. The Amateur Service has established an impressive record of providing lifesaving emergency communications during natural disasters and accidents, when more conventional methods of communications were rendered inoperable.

"Yet, because of the lack of [an] alternative, the Commission was forced to take away these 2 MHz in return for giving the Service primary access to an adjacent 3 MHz band. Passage of H.R. 707 will alleviate the pressure to take more spectrum from the Amateur Service by providing frequencies for new technologies in other bands."

The House bill differs somewhat from similar legislation introduced in the Senate by Senator Daniel Inouye (D-HI). Senate bill S. 335 includes authority for the FCC to assign spectrum in certain services by auction and also includes specific protections for the Amateur Service that were sought by the League during the previous session of Congress. As yet, there has been no action in the Senate on S. 335.

If the Senate adopts the Inouye bill in something resembling its present form, the ARRL will encourage the Conference Committee that resolves the differences between the bills to include those protections. *TNX Westlink Report No. 645, March 18, 1993; ARRL.*

Half of Lost 220 MHz Spectrum to be Replaced?

A partial replacement for 220-222 MHz may be on its way. In response to a request filed by the ARRL, the FCC has proposed a new secondary allocation for limited amateur operations in the 219-220 MHz band. If Docket 93-40 is put into effect as offered, the new band would be restricted for use by fixed, point-to-point ham communications, including packet radio backbone networks and repeater remote control and auxiliary stations.

The ARRL petition asked the Commission to authorize access to 216 to 220 MHz for amateur wideband packet radio networks and other point-to-point fixed communications. The League argued that the crowded conditions on other bands, primarily in urban areas, have prevented the completion of the long-desired national packet backbone network. In proposing ham access to the 219-220 MHz spectrum, the FCC says that it firmly believes that the creation of such a "primarily digital band" will foster technological experimentation and innovation at higher data rates and "facilitate the construction of a nationwide packet network."

The FCC noted that the creation of this new ham band will relieve the congestion that is now found on the 222 to 225 MHz band in certain geographic areas. They also feel that the ability of amateur operators to perform interference analysis, the directional nature of the proposed service, and the secondary nature of the allocation should adequately protect all primary and existing secondary operations in the 219 to 220 MHz band and the spectrum adjacent to it while permitting the completion of an amateur-radio-based emergency communications network. *TNX Westlink Report No. 645, March 18, 1993.*

ARRL Response to 222 MHz Proposal

On February 23, 1993, the League filed comments in FCC P.R. Docket 92-289, dealing with a proposed 222 MHz weak-signal subband and with Novice class license privileges. The League, in its comments, opposed repeater control operator privileges for Novices on the grounds that such would extend Novice privileges beyond the intent of the license, and noted that the Technician class, also an "entry level" license, provides such privileges.

The League otherwise reaffirmed its support for the proposed new rules, most of which were based on earlier ARRL recommendations, including a small weak signal segment on the 222 MHz band and expansion of Novice class privileges to include access to the entire 222-225 MHz band. *TNX Westlink Report No. 645, March 18, 1993.*

Scanner Rule Response

On February 22, 1993, the ARRL filed comments in FCC E.T. Docket 93-1, an inquiry of the Commission into how to implement the instructions of Congress to prevent the manufacture or importation of scanners capable of monitoring cellular telephones. The League's comments address concerns that the proceeding might inadvertently affect the availability of legitimate amateur radio equipment for the 902-928 MHz band.

Specifically, the League's comments point out that Section 15.121 of the proposed rules on scanners refers to "scanning receivers and frequency converters used with scanning receivers," which could be interpreted to restrict receiving

Continued on page 11

Earthwinds Balloon Crashes at Launch

For exclusive on-the-scene coverage of this long-awaited around-the-world attempt, see page 16.

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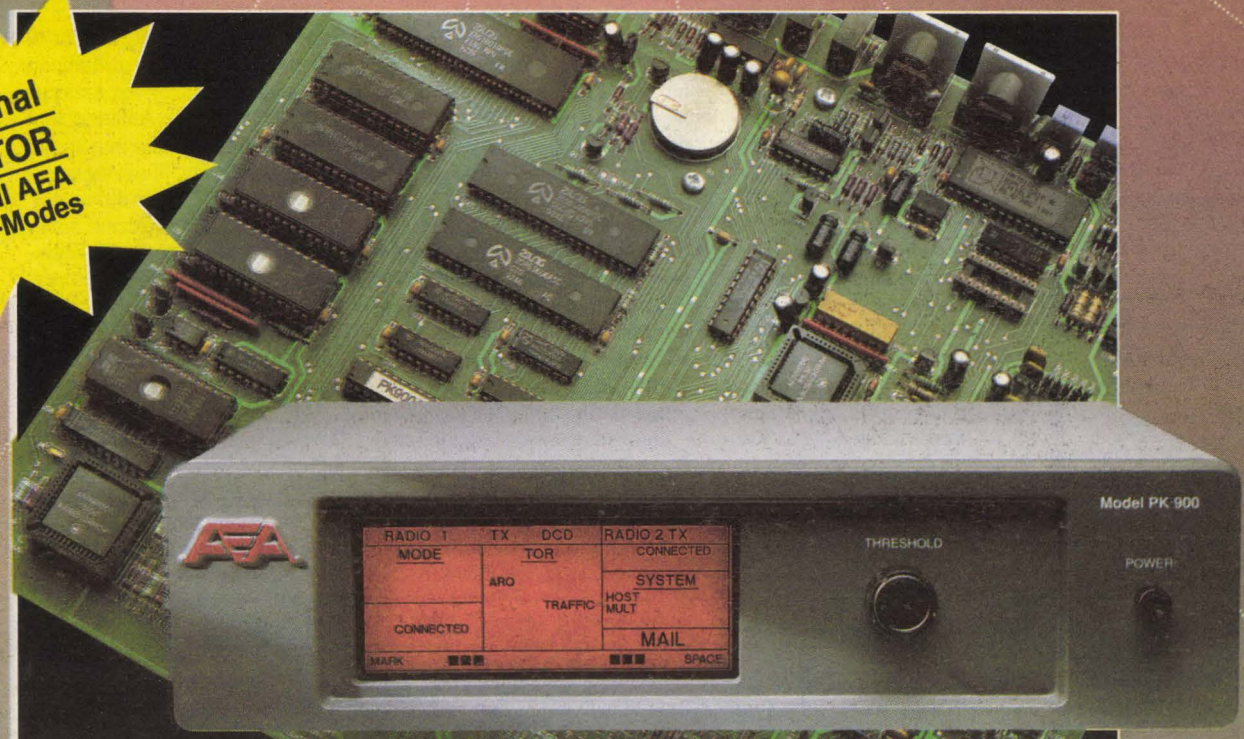

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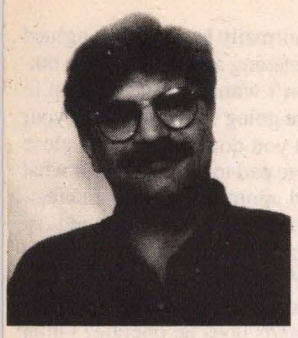


computers in the shack

by Jeffrey Sloman N1EWO

Back to Basics

Because of mail that I have received, and because so many of you are new to amateur radio, I have decided it is time to review. This month's column will look at what is available to the ham interested in operating in digital modes, and will give a basic idea of what is needed to get started.

Packet Radio, the Big One

For most hams the mention of "digital modes" brings packet radio to mind. While packet is neither the oldest nor the newest of the digital modes, it is undoubtedly the most widespread. Packet radio has taken its place next to 2 meter repeater operation as a staple of the amateur radio diet. It is used—and abused—to disseminate information of every variety allowed by part 97 (the FCC rules that govern ham radio). The urban or suburban ham who is without a packet station is missing easily 50% of what is happening in the ham radio community that surrounds him.

What IS Packet Radio, Anyway?

Amateur packet radio is a way of using radio to make error-free data transmissions between two stations. Packet uses a set of rules and conventions—a *protocol*—called AX.25. The "A" in AX.25 stands for amateur; "X.25" is a communications protocol used in networking—through phone lines or other land lines—which the developers of AX.25 adapted to the special needs of a radio connection.

For the sake of our discussion here, the radio connection is via FM simplex transmissions on the amateur 2 meter band—the most common way to work packet in the U.S.

Packet radio is the successor to older digital modes such as RTTY (Radio TeleTYpe), also called Baudot after the code that it uses. J.M.E. Baudot was an engineer in France during the 1800s who worked on telegraphy. Packet is superior to RTTY and its cousins in two principal ways: error-free transmission and frequency sharing. While RTTY is subject to damaged or lost data due to the condition of the radio link, packet radio stations will only display data which checks out mathematically as undamaged. RTTY is also limited to a single QSO (conversation) per channel, and so is wasteful of bandwidth.

Packet gets over these limitations thanks to its "access method," or the way that it uses a channel. AX.25 uses a technique called CSMA/CD (Carrier Sense Multiple Access/Collision Detection). This long name is just a label for some really common-sense ideas. The MA (Multiple Access) part means that more than two stations can share a frequency. The CS (Carrier Sense) is the way that they do it, by behaving almost identically to stations having a multi-station discussion on a repeater. Let's take a look at that.

What is the first thing you do—OK, the first thing you are *supposed* to do—if you want to use a repeater? Listen! This is your equivalent of carrier sense. If you hear another station (sense a carrier) you will not key up. Instead, you will wait 'til the other station is off the air. When the station is finished with its transmission, you can then make yours. Here's a subtlety not mentioned in the CSMA/CD name: Think about good repeater operations. When that station finishes transmitting, do you key up right away? No, instead you wait—a random amount of time within a limit—to see if another station intends to try to use the frequency. This wait is also used by AX.25 stations; it ensures that all the stations do not transmit at once.

In real-life repeater ops, group QSOs can get err . . . rambunctious sometimes, and people can forget the rules. When this happens stations all want to talk at once; they ignore the rules, and chaos ensues. Without that wait, nothing prevents stations from transmitting at the same time—doubling. We've all heard it. Well, AX.25 draws from real life again. The CD piece of CSMA/CD means "collision detection." This is AX.25's version of "Hey, you guys doubled, try it again."

This brings up an important point. As a user of a packet station, you are in control of the behavior of your station as much as you are when using an HT on a repeater. There are parameters that control how your station behaves relative to "good packet citizenship." This is YOUR responsibility. It is possible to set your parameters in such a way as to destroy the usefulness of the channel for everyone around you. IF YOU DON'T UNDERSTAND A PARAMETER, DON'T CHANGE IT. I have also heard stories about "advice" offered by hams to new packet users that is about as useful as a full-sized HF beam to an apartment dweller—in other words, NOT. Be careful where you get your information. Attend local hamfests that offer "packet forums." These should provide good information designed for your local conditions—there is no one right way. Leaving the parameters at the factory default is your best compromise, though. Well, enough of that. I'm sure you get the point.

"If you don't understand a parameter, don't change it."

What Did You Say?

The other improvement over the older digital modes is error detection and correction. This is more common sense. While RTTY is just a "data stream," one character after another, packet radio gets its name from the way it handles data—in packets. These data packets are sent one at a time, and each one must be acknowledged before the station moves on. (Actually, there is a parameter that allows more than one outstanding unacknowledged packet at a time. I only mention this to save those letter writers some time.) A packet—or, more correctly, a "frame"—has a "header" at the front which contains "addressing" information—where it is going, where it is from, and how it is supposed to get there—and a CRC (Cyclic Redundancy Check). OK, the address stuff is pretty obvious, but what is this CRC business? A CRC is a mathematical operation that is performed on the frame's data. It returns a result which is placed in the header. The CRC is the key to error detection.

When the receiving station gets a data frame, it performs the same CRC on the data. The station then compares the CRC result to the value in the header—if they match, everything's fine, no error. On the other hand, if the CRCs don't match up then something happened to the data between there and here. We've detected an error. Great, but what do we do about it? AX.25 uses an error correction scheme called ARQ (Automatic ReQuest to Send). ARQ works by having the receiving station send a request for retransmission when it detects an error—called a retry in the packet radio world. So the receiver asks the sender, "What did you say?" and the sender tries again. You can see from the discussion so far that a lot of packet station behavior is simple common sense. The reason it can look so complicated is because computers are basically stupid. Common sense means nothing at all to a computer. It does exactly what it is told—nothing more, nothing less. The complicated appearance of this stuff comes from the fact that we have to tell the computer every little piece of this puzzle. It will assume nothing.

New and Improved

I said before that AX.25 was a radio-enhanced version of X.25. Let's take a quick look at what was added to make it better for radio. First of all, X.25 was designed for a connection between two stations. As hams we want that, but we also sometimes broadcast (only to other hams, of course). So AX.25 adds an "unprotocol" mode. That is, the ability to transmit information to other stations without being connected to them. This is used for beacons, IDing, and sometimes for round-table discussions. Unprotocol mode has the disadvantage of no error correction. You'll either see it perfect or you won't see it at all.

The second major change is a concept called "digipeaters." A digipeater—commonly called a "digi"—is any station on the channel that receives and then passes on frames to increase the range of the sending station. To get an idea of how this works, let' s look at how a digi is used. To make a connection to another station, the "connect" command is used. It is abbreviated as "C." To connect directly to another station it looks like this:

C AA9FP

This will connect me to Mike's station, if he can hear me and I can hear him. If this isn't the case, but a station in the middle can hear both of us, I can use it to make the connection:

C AA9FP V NT9J

This works like this: My CONNECT frame is transmitted and heard by NT9J. Jack's station then stores the frame and as soon as it gets a chance it resends it, marking it as having passed through his station. This marking part is important because the frame must go through the sequence of digits as you specify them (up to eight). Even if a station farther down the list can hear your frame, it will not respond out of turn. Now Mike's station can hear my connect request since he can hear NT9J, and the connection is automatically established through his station.

Next Month

Now that we've covered the basics of packet radio's AX.25 protocol, we'll take a look at the hardware components of a working station. In future columns we'll look at other digital modes, and some software stuff as well.

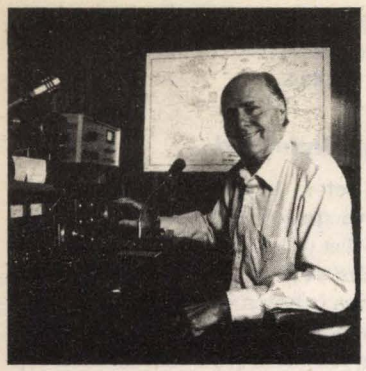
I'm always interested in hearing from readers. You can use paper mail—or better yet, electronic mail at one of the addresses below.

Packet Radio: No business please! Still, I'd like to get messages from readers. If you need a place to send your first packet message, try here:

N1EWO@NØARY.#NOCAL.CA.USA.NA

Internet: Questions, statements, stuff to print can go here. You can reach the Internet from CompuServe. Check out the online help: jsloman@bix.com

Until next month, 73 de N1EWO. RF



QLF

by Wayne Green W2NSD/1

Rag-Chewing For Fun

One measure of intelligence is how long it takes someone to get fed up with exchanging the same old crap over and over . . . how long it takes before they begin to start looking for people to actually talk with instead of broadcast to. Some old-timers have been exchanging signal and weather reports, and not much else, for decades.

It's a pity that we've allowed our ham communications systems to evolve on a simplex basis, with one of us talking at a time, instead of duplex, as on the telephone. It's difficult enough to generate conversations when you meet someone new that you can see and hear, but trying to find mutual conversational ground with someone you can't see and can't hear while you're talking is a real challenge.

If you're into pioneering, you might consider developing a system which will allow us to at least talk to each other at the same time. We can do this via either time or frequency splitting. Eventually we'll have video along with voice, if you'll start working on it.

In the meantime, let's get along as best we can with what we've got. I've been hamming for over 50 years now and contacts haven't changed much. Oh, we're using sideband on the low bands and NBFM on the VHF bands, but our conversations haven't changed. We're still where we were 50 years ago as far as actually talking with each other is concerned. We're still in the dark ages when it comes to communicating.

Lids

At times I get discouraged trying to find someone interesting to talk with. There seems to be an inordinate number of lids. I'm not sure who invented the term, but it probably stands for Lousy Inconsiderate Dumbbell. Nerds, dweebs. Lids aren't hard to spot—they're the ops who tune up on top of a contact in progress. They salt their conversations with ham clichés. They use "Q" codes on voice. The QTH here, etc. They "pull the big switch." They are going to "modulate the mattress." The "XYL" or "harmonics" are calling. In pile-ups they call endlessly without listening. You get the picture. Lordy, you'd think we were deep in CB country. Spare me.

Lids call CQ for a lot longer than necessary. Lids use awful phonetics for their calls; or worse, use the international phonetic alphabet when talking locally. Lids have set transmissions which include their handle, spelled out, QTH, the make and model of their rig, their antenna, and probably a brief weather report, your signal report, and over to you.

Okay, we've heard a few lids, so how does one avoid such radio halitosis? Not so hard. I avoid talking about my equipment unless the other chap particularly asks. Unless he has a lousy signal or one so big I can't believe it, my curiosity over what brand of equipment he's bought is low. Oh, 50 years ago, when all rigs were homemade, it was interesting to find out what the other chap had built and how it was doing for him. If the contact is solid I don't use any phonetics, but I might spell out something tricky. My name (not handle), Wayne, isn't very tricky. Nor is Peterborough.

The most important thing to remember when you are in contact with someone is to listen to what he's saying for clues on things to ask him about. The more you talk about *him*, the more fantastic the contact is going to be for him, and for you. So find out what he does and ask questions. There is nothing you can say that will be even remotely as interesting to him as talking about him.

On occasions where you run into someone with severe mike-fright and aren't able to pry anything of interest out of him, you want to have a few short stories . . . interesting stories, please . . . on tap.

Since you'll normally have your ear glued to the speaker, listening attentively to the other chap, you don't want to have to keep in mind what you're going to say when it's your turn. As soon as you do that your ears close off. So keep a note pad to remind you of what to cover. A good approach on your interesting story cache is to list the topics and post the list where you can easily see it. The less you have to think while you're transmitting, the better your material will flow.

What other bands does he operate? Other modes? What DX has he worked recently? How about his kids? Well, grandkids, considering he's probably my age. Or great-grandkids.

I hope that all makes sense.

If you run into me on 20m or 10m someday I'm going to want to know about *you*. Of course I'd love to talk about any of a hundred subjects, but it isn't easy working in a list of my interests, looking for something we have in common.

I hope some of you will recognize this egregious fault in our system and come up with some way I can dump a list of my interests into your computer when we contact so your computer can look for common interests and get us off and running. There are probably places we've both been, if you've been anywhere. We probably have other hobbies in common, if you have other interests.

If you're technically inclined you might stop wasting time and get busy developing the computer system I suggested so we can all spice up our contacts. We should be able to dump a whole page of stuff in a couple seconds, all automatically. Hey, that almost sounds like packet, doesn't it? RF

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letters

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Gerald F. Payoff, P.O. Box 215, Rome NY 13442 I am a non-ham who would really like to get involved with ham radio. I have always been interested in radio, but have been unable to locate anyone in my area to get me started.

Could you please send me some information about getting started? It has to be basic because at the moment I know little about ham radio.

Anybody in the Rome, New York, area want to help Gerald?—David N1GPH

Arnold Samuels KH6COY, Ocean Shores WA I think we ought to get amateur radio back to a one-license structure with a 5 wpm CW requirement. It would very much simplify the license procedure and would cut administrative costs at the FCC level, which would be appropriate in today's cost-cutting climate. What do you think? Furthermore, I propose that a license fee be established to pay for the administrative cost of this "hobby."

Since we've just gone through a major license structure change with the codeless Technician license, the FCC is unlikely to consider any further changes for the next few years.

If there was a way to ensure that license fees remained in the FCC budget and were spent on the Amateur Radio Service, I'd be all for it. A license fee that gets placed in the Feds' general operating budget is simply a tax, and I already pay enough taxes.—David N1GPH

Kathleen R. Szakonyi, Smithsburg MD I am writing this letter to express my sincere appreciation to all amateur radio enthusiasts, and to one operator in particular. Thank you to Wayne N1MUA of Livermore, Maine, for his efforts to interpret a very weak signal and get us out of a tight spot on March 4. He really lived up to the principles of amateur radio.

We had experienced a severe ice storm which was confined to our local area. Trees were down everywhere, knocking out power and phones and blocking roads early in the day. High winds were uprooting trees all around our home, but all I could think of was that my children were stranded 12 miles away with no one to pick them up from school and I had no way to communicate my dilemma (I thought).

Fortunately, my husband is a ham radio enthusiast. He had a rig which would operate from a 12 volt power source. With the antennas laying in a tangle across our deck, he hooked it up and said, "I'll give it a try." It was around 1:30 p.m. on a Thursday afternoon, not prime time by any means.

Luckily, Wayne was monitoring. He picked us up and spent two hours getting a phone number for my father over the air and putting through a long distance call to make sure that the children were safely in proper care. He called us back over the radio to assure us that the contact had been made and that our message had gotten out. With everything else we had to deal with at that time, knowing that we didn't have to worry about the children was a tremendous relief.

I know this experience doesn't rate as much notice as the devastation of a hurricane, earthquake or other major disaster, but I really appreciated that the network was there when we needed it. RF

Capacitance

by Larry R. Luchi W7KZE

[Editor's Note: This technical discussion of capacitance is a bit more advanced than what we usually publish in Radio Fun, *and it may leave some of you in the dark. If so, read it through a few times—slowly—and things should begin to sink in. If you want to get the most out of amateur radio, you've got to really understand this stuff—not just memorize a bunch of answers for a test.*

We've asked Mr. Luchi to prepare a series of articles focusing on various electronic components and their properties. We'll publish them from time to time, and if you stick with them, you'll be well on your way to a solid foundation in electronics.—David N1GPH]

The General, Advanced and Extra amateur radio exams all have common questions from a pool on the subject of "Capacitors and Capacitance." This article is for those hearty amateurs who are on the road to upgrade.

A capacitor consists of an insulator (called a dielectric) between two conductors. The conductors make it possible to apply voltage across the insulator. Different types of capacitors are manufactured for specific values of *C* (symbol for capacitance). They are named according to the dielectric. Common types of dielectrics are: air, ceramic, mica, paper, plastic, and electrolytic. Capacitors used in electronic circuits are small and economical. The most important property of an ideal capacitor is to block DC current and pass AC current. The higher the AC frequency, the less opposition for AC voltage or current.

Capacitors are a common source of trouble because they can have either an open circuit or a short circuit through the dielectric. Electrolytic capacitors that are physically located near heat-radiating devices tend to dry up, thereby causing a short circuit. This article describes these problems, and includes the method of checking a capacitor with a digital ohmmeter, even though a capacitor is actually an insulator.

Capacitance

What is a dielectric? A nonconducting material that does not pass DC electric current. It is possible for dielectric materials such as air or paper to hold an electric charge because free electrons cannot flow through an insulator. The electric field distorts the molecular structure so that the dielectric is no longer neutral. The dielectric is actually stressed by the invisible force of the electric field. As evidence, the dielectric can be ruptured by a very intense field with high voltage applied across the capacitor.

The factors that determine the capacitance are the area of the plates exposed to each other, and the composition of the nonconducting material between the plates. Two plates, each with an area of $1"^2$ when separated by 0.001" of air, produce a capacitance of 225 pF. If each plate area is doubled (spacing remaining 0.001"), the capacitance doubles to 440 pF. Capacitance is directly proportional to the area of the plates.

If the spacing of the two $1"^2$ plates is increased to 0.002", the path of the electrostatic lines of force between the negative plate and the positive plate is twice as great, resulting in only half as intense an electrostatic field and only half as much capacitance. Capacitance is inversely proportional to the space between plates.

The nonconducting *dielectric* material determines the concentration of electrostatic lines of force. If the dielectric is air, a certain number of lines of force will be set up for a given applied voltage. Other materials offer less opposition to the formation of electrostatic lines of force. For example, with one type of paper instead of air, the number of electrostatic lines of force between the plates may be twice as great. Such a capacitor will have twice as much capacitance, and will have twice as many electrons flowing into and out of it with the same applied source voltage. The paper is said to have a *dielectric constant*, or *specific inductive capacity*, twice that of air. Capacitance of a capacitor is directly proportional to the dielectric constant. The approximate dielectric constant, or specific inductive capacity, of some common dielectric materials is given in Table 1.

The dielectric constant of solid dielectric materials may decrease with an increase in frequency. The molecules of the dielectric do not have sufficient time to conform to the rapidly changing electrostatic lines of force that they must support. If the lines of force cannot be fully developed in the dielectric molecules, the dielectric constant and the capacitance will be less. Therefore, a 0.1 µF paper capacitor may have 0.1 µF at 1 MHz but will have considerably less at 100 MHz.

Charging a Capacitor

These are the two main effects with capacitors. Applied voltage puts charge in the capacitor. The accumulation of charge results in a buildup of potential difference across the capacitor plates. When the capacitor voltage equals the applied voltage there is no more charging. The charge remains in the capacitor, with or without the applied voltage connected. This is illustrated in Figure 1.

Discharging a Capacitor

The capacitor discharges when a conducting path is provided across the plates, without any applied voltage. Actually, it is only necessary that the capacitor voltage be more than the applied voltage. Then the capacitor can serve as a voltage source, temporarily, to produce discharge current in the discharge path. The capacitor discharge continues until the capacitor voltage drops to zero or is equal to the applied voltage.

Dielectric Losses

Almost all the energy stored in the electrostatic field of a capacitor is converted into some other form of energy when the capacitor is discharged. However, two losses occur in the dielectric itself.

Electrons on the negative plate of a charged capacitor may find a high-resistance path to the positive plate through the dielectric, forming a leakage current to the other plate.

Another kind of dielectric loss is indicated by heat in the capacitor. It is caused by the friction of the molecules of the dielectric material as they are changed from one strained position to the opposite by any reversing of the electrostatic lines of force. This process is called hysteresis, and it is normally significant only when an alternating current produces rapid charging and discharging of the capacitor. It increases as the frequency of the AC increases. For this reason, many capacitors operate satisfactorily at lower, but not at very high, frequencies.

The Farad Unit of Capacitance

With more charging voltage, the electric field is stronger and more charge is stored in the dielectric. Figure 2 shows that the amount of charge stored in the electric field is proportional to the applied voltage. Also, a larger capacitance can store more charge. These relations are summarized by the formula:

$$Q = CV$$

where Q = charge, in coulombs
C = capacitance, in farads
V = voltage, in volts

The C is the physical constant, indicating the capacitance in terms of how much is stored in the dielectric with a potential difference of one volt, the capacitance is one *farad*.

Practical capacitors have sizes in millionths of a farad, or smaller. The reason is that typical capacitors store charges of microcoulombs or less. Therefore, the common units are:

1 microfarad = 1 µF = 1 x 10^{-6} F

1 picofarad = 1 pF = 1 x 10^{-12} F

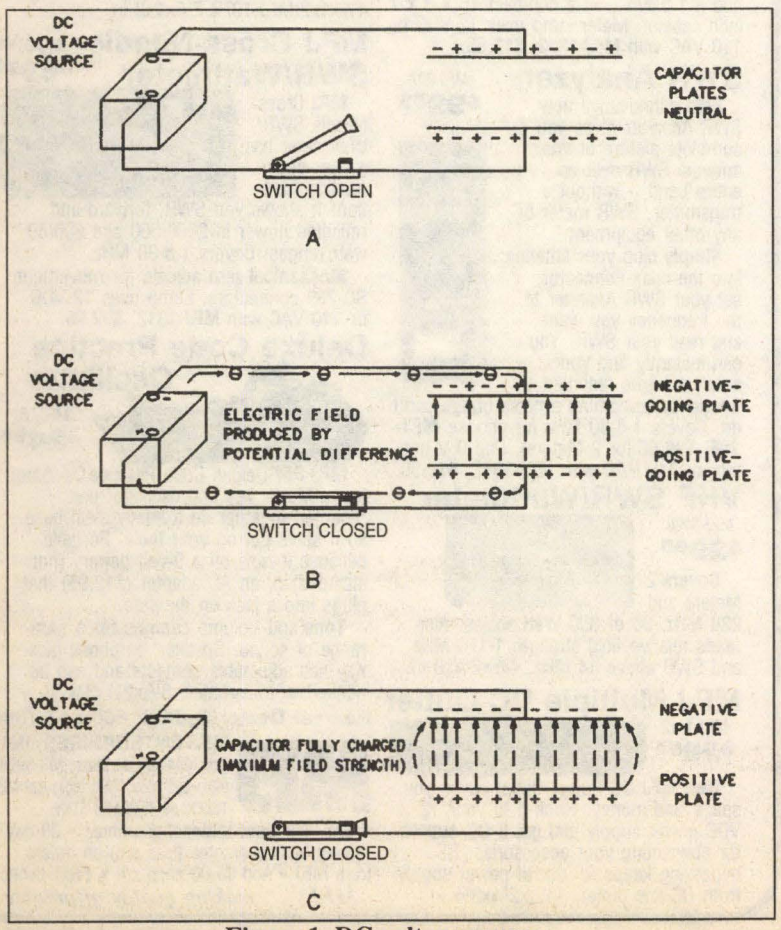

Figure 1. DC voltage source.

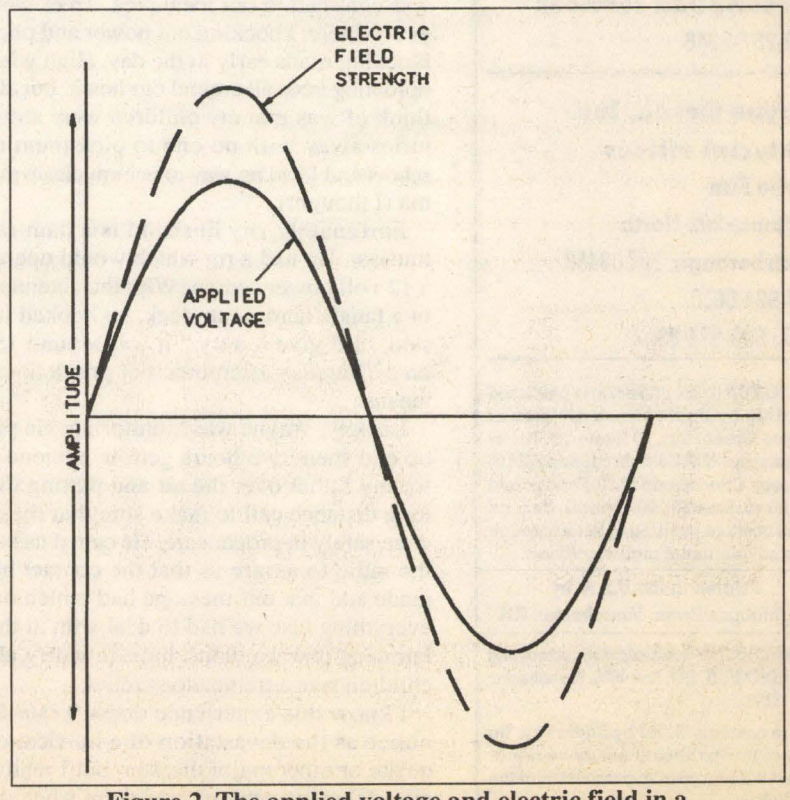

Figure 2. The applied voltage and electric field in a charged capacitor are in phase.

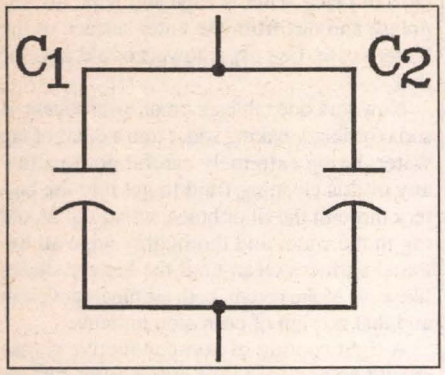

Figure 3. Capacitors in parallel.

Types of Polarized Capacitors

Polarized capacitors are *electrolytic capacitors*. There are two major types of electrolytic capacitors: aluminum and tantalum.

The essential parts of an *aluminum electrolytic capacitor* are the aluminum plates and the dielectric *aluminum oxide*. The electrolyte, which is a conductor, is a chemical compound or mixture in either a dry or a paste form. The separator is made from porous paper or gauze which is easily penetrated and saturated by the electrolyte. The composition of the electrolyte varies, depending on the desired capacitor characteristics and rating, but is usually quite alkaline.

The electrolyte aids in electrochemically forming and maintaining the aluminum oxide on the positive plate *when the plate is positive with respect to the electrolyte*. If the polarity is reversed, the electrochemical reaction reverses and a large current flows through the capacitor as the oxide is removed. This large current heats the electrolyte and destroys, often with a violent explosion, the capacitor. Therefore, the polarity of the electrolyte must be observed.

The two aluminum plates of the electrolytic capacitor are long narrow strips of aluminum foil which are alternately stacked with two strips of electrolyte-saturated separation material. The positive plate has an oxide layer on *both* surfaces. If it did not, the electrolyte would short the unoxidized surface of the positive plate to the negative plate.

One characteristic of all rolled (tubular-shaped) capacitor elements should be noted: Rolling almost doubles the effective plate area. This is because, except for the last turn of the outside foil, both surfaces of the foil are utilized.

A *tantalum electrolytic capacitor* is different. Instead of the rolled foil construction, the tantalum capacitor has a tantalum slug or pellet for its positive plate (or anode, as it is often called for a tantalum capacitor). This slug is covered by a very thin layer of *tantalum pentoxide*, which is the dielectric. Because tantalum pentoxide has a higher dielectric constant than does aluminum oxide, the tantalum electrolytic has a higher capacitance-to-volume ratio than does the aluminum electrolytic.

The electrolyte, in either the solid dry form or the wet gel form, surrounds the pentoxide layer. Finally, the electrolyte is encased by the negative plate (or cathode as it is often called) which is often made of a thin layer of silver lined with a thin layer of graphite. The capacitor element is then encapsulated in an epoxy coating or in a metal case.

Table 1. Dielectric Constants

Material	Dielectric Constant
Vacuum	1
Air	1.0006
Rubber	2-3
Paper	2-3
Ceramic	3-7
Glass	4-7
Quartz	4
Mica	5-7
Porcelain	6-7
Water	80
Plastic film	2-3
Tantalum oxide	25
Barium titanate	7500

Parallel Capacitances

Connecting capacitances in parallel is equivalent to adding the plate areas. Therefore, the total capacitance is the sum of the individual capacitances, as shown in Figure 3.

A 10 µF capacitor in parallel with a 5 µF capacitor, for example, provides a 15 µF capacitance for the parallel combination. The voltage is the same across the parallel capacitors. **Remember that adding parallel capacitances is opposite to the case of inductances in parallel and resistances in parallel.**

Series Capacitances

Connecting capacitances in series is equivalent to increasing the thickness of the dielectric. Therefore, the combined capacitance is less than the smallest individual value. Series capacitance is calculated by the reciprocal formula:

$$C_t = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{\quad} + \ldots \text{etc.}}$$

Any of the short-cut calculations for the reciprocal formula apply. For example, the combined capacitance of two equal capacitances of 10 µF in series is 5 µF. That is, if all capacitors are of equal value you divide the value by the number of capacitors.

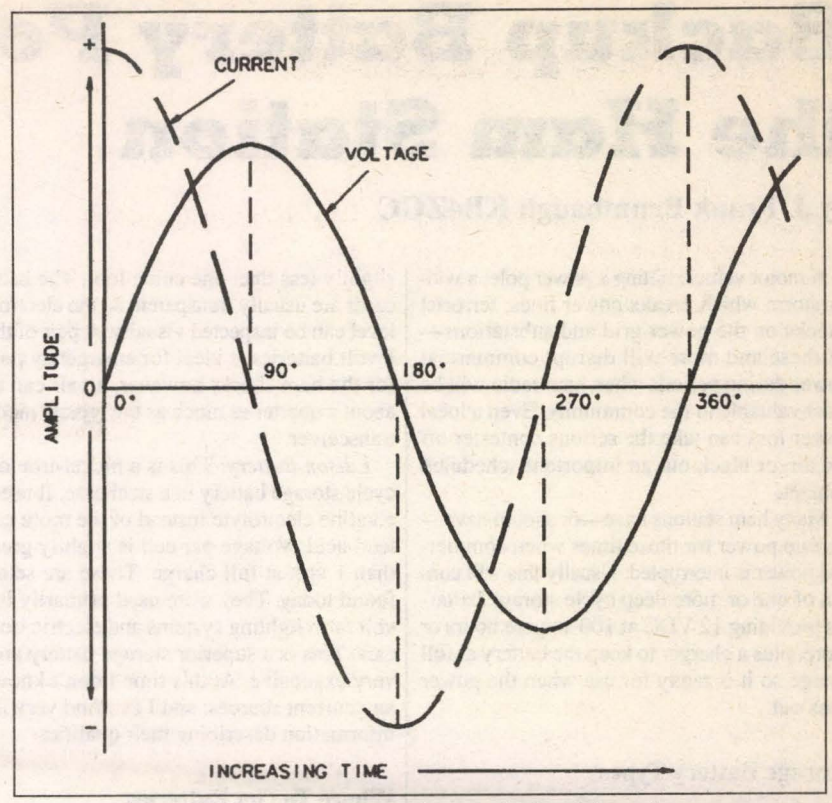

Figure 4. Voltage-current phase relationships when an AC voltage is applied to a capacitor.

Phase Angle Between Current and Voltage

The current in an ideal-capacitor circuit reaches its peak value when the voltage is zero. (An ideal capacitor is one which has a dissipation factor of zero.) As shown in Figure 4, this causes the current to be exactly 90 degrees out of phase with the voltage. Notice that the *current leads the voltage* by 90 degrees because the current reaches its + peak before the voltage reaches its + peak.

Troubles in Capacitors

Capacitors can become open or short-circuited. In either case, the capacitor is useless because it cannot store a charge. A leaky capacitor is equivalent to a partial short circuit where the dielectric gradually loses its insulating properties under the stress of applied voltage, lowering its resistance. A good capacitor has very high resistance on the order of megohms; a short-circuited capacitor has zero ohms resistance, or continuity; the resistance of a leaky capacitor is lower than normal.

Checking Capacitors with an Ohmmeter

If an ohmmeter reading immediately goes almost to zero and stays there, the capacitor is short-circuited. Using a digital multimeter, the display will show 0000 or 0002.

If the capacitor shows charging, but the final resistance reading is appreciably less than normal, the capacitor is leaky. Such capacitors are particularly troublesome in high-resistance circuits. When checking the electrolytic, reverse the ohmmeter leads and take the higher of the two readings.

If the capacitor shows no charging action but just reads very high resistance, it may be open. Some precautions must be remembered, however, since very high resistance is a normal condition for capacitors. Reverse the ohmmeter leads to discharge the capacitor, and check it again. Remember that capacitance values of 100 pF or less normally have very little discharging current for the low battery voltage of the ohmmeter. RF

Backup Battery Power for the Ham Station

by J. Frank Brumbaugh KB4ZGC

A motor vehicle hitting a power pole; a winter storm which breaks power lines; terrorist attacks on the power grid and substations—all these and more will disrupt commercial power during periods when ham radio will be most valuable to the community. Even a local power loss can take the serious contester off the air, or black out an important scheduled contact.

Many ham stations have—or should have—backup power for those times when commercial power is interrupted. Usually this will consist of one or more deep cycle storage batteries providing 12 VDC at 100 ampere hours or more, plus a charger to keep the battery at full charge so it is ready for use when the power goes out.

Storage Battery Types

There are a number of different types of storage batteries which are suitable for powering the typical ham station. Those most useful are discussed below.

Automobile Storage Batteries: Although not the first choice, the battery from your automobile can be used in an emergency and will power the modern 100 watt transceiver for a short period of time. But because this type of battery is designed primarily to produce a high current for a short period, followed by immediate charging by the alternator, it should be your last choice if more suitable batteries are available.

Deep Cycle Lead-Acid Battery: These batteries are used primarily for powering accessories—radio, television, lights, etc.—in recreational vehicles and boats, and for powering electric fishing motors. They are available in several sizes and produce 35 to 100 ampere hours or more, at several terminal voltages. They look very much like the ordinary automobile battery. Sizes 24, 27 and 28 are most suitable for powering the ham station in an emergency. These batteries are designed to provide relatively small amounts of power over long periods of time, making them much more useful for backup power.

This type of battery is quite expensive, and it is available in fewer stores, primarily marine equipment stores or RV supply stores, making it difficult to locate.

Gel Cell Battery: These are deep cycle lead-acid batteries with the electrolyte in gel form. They are often used for emergency lighting, in combination with lamps and chargers. Public buildings, stores, factories, etc. have these mounted to illuminate exit paths and other important areas. They provide light when commercial power is lost, coming on automatically when needed.

Most of these batteries are either 6 or 12 volts and have limited capacity, seldom more than about 25 ampere hours. They are also very expensive and have limited use as station backup batteries, except for QRP installations.

Deep Cycle Lead-Calcium Battery: Although similar in function to the deep cycle lead-acid battery, this is a heavy-duty battery used primarily for backup power in factories and also by utility companies, where they are maintained on trickle charge for use in emergencies to power equipment. They are large, heavy, and usually in 6 volt size and rated at 100 ampere hours or more. A typical 6 volt battery weighs about 60 pounds and has a volume slightly less than one cubic foot. The battery cases are usually transparent so the electrolyte level can be inspected visually. A pair of these 6 volt batteries is ideal for emergency power for the ham shack; however, a pair can cost about a quarter as much as the typical modern transceiver.

Edison Battery: This is a nickel-iron deep cycle storage battery in a steel case. It uses an alkaline electrolyte instead of the more usual lead-acid. Voltage per cell is slightly greater than 1 volt at full charge. These are seldom found today. They were used primarily in 32 volt farm lighting systems and electric trolley cars. This is a superior storage battery and is very expensive. At this time I don't know of any current sources, and I can find very little information describing their qualities.

Where To Get Batteries

Ordinary automobile storage batteries are available everywhere and are relatively inexpensive. They are not recommended for station battery backup power except in an emergency when better batteries are not available.

Deep cycle lead-acid batteries are occasionally available in large department stores but will be found primarily at marine equipment stores and at recreational vehicle supply stores. They are very expensive when purchased new. Used batteries may be found at boat yards, marinas, and wherever outboard motors are serviced and repaired. It should be possible to find suitable batteries for considerably less money than the same batteries new.

If you use this source, take a voltmeter with you and ask to inspect the batteries before you buy them. Take the filler caps off each cell and look inside to see if the electrolyte covers the plates. If plates are exposed, the battery may be severely damaged. Measure the voltage of the entire battery, which should be greater than 10.5 volts for a 12 volt battery. Then measure the voltage across each individual cell if this is possible. Voltage should be close to 2 volts and there should be little if any variation in voltage between cells.

If the battery passes the above tests, borrow a hydrometer and check the specific gravity of the electrolyte in each cell. All should be above 1.100 and all readings should be nearly the same. If this checks satisfactorily it's time to haggle over the price. Try to get a battery with at least 100 ampere hours capacity. This will be imprinted on the battery case.

Gel cell batteries will be the most useful for QRP stations and for portable gear such as is taken on camping trips, etc. They are available new and used from numerous mail order parts dealers. They are expensive new, and not all used gel cell batteries available by mail are in the best condition—let the buyer beware!

A better, and usually cheaper, source of good used gel cell batteries is those taken out of service as emergency lighting batteries. Regulations require that batteries in emergency lighting service be replaced at specific time intervals, whether or not they have ever been used to power the lights. Because these batteries have been kept on trickle charge and are inspected on a regular basis, most should be nearly as good as new batteries.

Emergency lighting equipment is usually serviced and maintained by a local company whose name will be on a label on individual installations. Ask employees in any store or bar in which you notice these lights, above doors or high up on the walls, who services them. Perhaps you can read the label on one of the fixtures. The Yellow Pages of your telephone directory is another source for locating the servicing company. When you locate this information, visit them and ask about getting some of the batteries they have removed from service. Because they are now "salvage" they have little value to the company so you should be able to get those you want for little money, and sometimes free of charge for hauling them off.

Deep cycle lead-calcium batteries are by far the best available batteries for ham station backup use. Utility companies and many manufacturing plants maintain them on trickle charge for emergency backup power. They are scrupulously inspected and maintained, and are removed from service and replaced at specific time intervals. Because these batteries have had little or no actual use, they are practically new when removed from service as "salvage" batteries.

" If at all possible, make the lead-calcium battery your first choice for emergency backup power for your ham station."

Motors are serviced and repaired. It should be possible to find suitable batteries for considerably less money than the same batteries new.

Because hams often are employed by utility companies and manufacturers, try to locate a ham who works there. Ask at your radio club meeting and on the local repeater. He, or one of his ham friends, will know what happens to salvage batteries.

Some companies return salvage batteries to the manufacturer for the value of the lead, currently about 50 cents per pound. Others allow employees to take them home, either at a nominal charge or free. Some turn them over to hazardous waste removal companies for disposal. (Both lead and sulfuric acid are classified as toxic waste.)

Hams who have access to these salvage batteries, being hams, probably will be willing to trade a pair of 6 volt, 100 ampere hour batteries for some gear you no longer want, or sell them for a nominal sum. Even if you have to pay a few dollars each, these batteries will be a bargain! If at all possible, make the lead-calcium battery your first choice for emergency backup power for your ham station.

Battery Maintenance

Assuming you aren't wealthy, you probably have obtained used, salvage batteries. They will be dirty, probably greasy, and there may be corrosion on the terminals and on the case. They must first be cleaned.

Work on some old newspapers and scrape off any green or yellowish-white corrosion from the terminals. Do not allow any of this material to get into the battery—leave the filler caps in place. Then scrape and wipe off any grease and dirt from the outer surface of the battery case. Use paper towels or old rags for this.

Now mix one tablespoon of bicarbonate of soda (ordinary baking soda) into a quart of tap water. Being extremely careful not to allow any of this cleaning fluid to get into the battery through the filler holes, wring out an old rag in the water and thoroughly wipe all external surfaces clean until the battery shines like new. Make certain both terminals are clean and that no sign of corrosion remains.

A light coating of non-conductive grease should be applied to the entire outer surface of the battery when it is clean and dry. A silicone grease such as Dow Corning DC-3 or DC-4 is recommended because it will not melt at the highest temperatures to be expected, even in the tropics. You can use a yellow grease made for automobile use, but even ordinary petroleum jelly will suffice. This will protect the battery from any electrolyte which may spray from the filler caps during charging, or inadvertent drips from the hydrometer when used for checking specific gravity of the electrolyte.

Now inspect the electrolyte level in all cells of the battery. Look inside the filler holes in lead-acid batteries for a mark indicating the proper level. Lead-calcium batteries in transparent cases will have low and high level marks for electrolyte level marked on the ends of each cell. If the level is not the same in each cell, use a hydrometer to transfer electrolyte between cells so each contains the same level.

Electrolyte levels will probably be below the "Fill to Here" marks in the filler holes of lead-acid batteries, and below the high level mark on lead-calcium batteries. *Using only distilled water*—you can get this in many supermarkets and drug stores—top off each cell to the proper electrolyte level. *CAUTION: Use only distilled water when topping off the electrolyte. Never use tap water. Make sure the battery plates are covered with electrolyte at all times.*

Charging

Your batteries should be fully charged now that they have been cleaned and the electrolyte is at the proper level. Gel cell batteries should be charged with a constant voltage, controlled current charger to a terminal voltage of 13.8 volts for a 12 volt battery, or 6.9 volts for a 6 volt battery. When this fully charged voltage is reached, the charger should taper off to provide a trickle charge just sufficient to maintain full charge. A suitable charger is described in recent editions of the *ARRL Handbook*.

Lead-acid and lead-calcium storage batteries are normally charged at a rate approximately 10 percent of the ampere hour rate, i.e. 10 amperes for a 100 ampere hour battery. This is the maximum current which should be supplied. An adjustable battery charger made for automobile storage batteries is suitable. When fully charged, a lead-acid battery can be floated across the output of the station 13.8 VDC power supply and will be maintained ready for use when needed. The lead-calcium battery can be floated across this power supply if the voltage is reduced to 13.2 VDC.

Monitoring Battery Charge Level

Lead-acid and lead-calcium batteries, except "maintenance-free" automobile storage batteries, should be checked periodically with a hydrometer, which may be obtained from an auto supply store for a few dollars. Be sure the one you get is intended for batteries and not for antifreeze measurements!

Full charge electrolyte specific gravity for

these batteries is 1.265. Instructions provided with the hydrometer allow adjusting the actual reading for temperature of the electrolyte to get actual specific gravity in all cases. A fully discharged battery will give a specific gravity reading of only 1.100. *CAUTION: Never allow a storage battery to be discharged more than 60 percent of full charge before charging it again. (Hydrometer reading of 1.2000 indicates 60% discharged.)*

The specific gravity readings given here apply *only* if the battery has been discharged at a *low rate over a long period of time*. After rapid discharge over a short period, there may be little difference in hydrometer readings.

Another method of measuring and monitoring battery charge is to use a suppressed zero, expanded scale voltmeter permanently connected across the battery. Such a meter might measure only the range between 10 and 15 volts, thus making it easy to note the state of charge at a glance. A meter indication of 13.8 VDC (lead-acid) or 13.2 VDC (lead-calcium) indicates the battery is fully charged. A voltage of 10.5 VDC indicates a fully discharged battery of either type. Discharge by 60 percent of full charge, the maximum recommended level, produces a voltage of 11.8 VDC (lead-acid) or 11.6 VDC (lead-calcium). This is equivalent to a hydrometer reading of 1.200.

Except for ordinary automobile storage batteries, never apply a "quick charge" on a deep cycle battery. The high current can increase the internal temperature enough to buckle the plates, and could cause the battery to explode and spray hot acid around the area. Always use a controlled voltage, controlled current charger on deep cycle batteries, one in which the charging current decreases as a full charge is approached, and which then supplies a small trickle current to maintain the battery at full charge. Floating the fully charged battery across the station power supply, as explained above, after it is fully charged, will maintain the battery ready for use when needed.

The battery can, of course, remain connected to the charger, and when current is drawn from the battery *and commercial power is still available* to power the charger, it will increase its current to aid in maintaining the battery charge level.

Power for the Ham Station

Your fully charged deep cycle battery can be connected directly to the accessory terminals of your station power supply as indicated above. These terminals can also provide power for a DC lamp and other accessories necessary for continuing operation during periods when commercial power has been disrupted.

Most modern solid-state transceivers are rated for proper operation over a range of about 12 to 15 VDC. Below 12 volts most will still operate but at reduced power, at least down to 11 VDC.

Cables and Connectors

Purchase new connectors from an auto supply store if your batteries have post connectors. If the terminals have holes for bolts—most will clear 1/4-20 bolts—you can probably find copper bolts, nuts and washers at either auto supply stores or electrical supply houses.

The wiring from batteries to your rig should be a minimum of AWG-8, and AWG-6 or AWG-4 would be better to reduce voltage drop. These wires must be insulated and be stranded copper. They should also be as short as possible. As an example, for a pair of 5-foot wires (10 feet total length) and at a current drain of 20 amperes, AWG-8 wires will exhibit a voltage drop of 0.13 VDC! Under the same circumstances, AWG-6 wire drops 0.08 VDC and AWG-4 wire drops 0.05 VDC.

These large wires are expensive. You might be able to locate short "scrap" lengths free or for the value of the copper if you ask electrical installers and electricians, preferably those who do industrial electrical contracting. But whether you buy them or scrounge them, use the largest diameter cable you can locate. Another source of cable which may be suitable is the better quality automobile jumper cables, though these wires are seldom larger than AWG-8. Because your regulated power supply is rated for about a 700 mV regulation, it will be worth a few dollars to not insert too much of a voltage drop in your battery cables.

After making connections to the battery, make certain the metal-to-metal contact is clean and tight. Then smear either silicone grease or any other nonconducting grease over both battery terminals. This will prevent corrosion from forming, corrosion which can erode and weaken cable ends and connectors and which can introduce resistance which adds additional voltage drops when current is drawn from the battery.

Battery Location

Your batteries should be as close to the rig as possible, but also in a well ventilated area. Do not confine them to a covered box. *WARNING: Charging storage batteries generates hydrogen gas, which is flammable and explosive. Do not use open flames nor allow electrical arcs to occur near batteries.*

Storage batteries should not be placed directly on concrete floors. Instead, place them on an acid-resistant insulating material to protect the floor from any acid which may spray from the battery or be spilled. Rubber mats or vinyl runners are suitable, as are the battery trays made especially for marine batteries in boats and sold by marine equipment dealers. Fasten a rubber or plastic cup to the wall beside your batteries to hold the hydrometer and prevent acid dripping from it from causing damage. *CAUTION: Be sure to connect the negative battery terminal to the station DC ground with a short, direct connection. Heavy wire or braid will be suitable.*

When your battery has been installed and connected properly, make certain that no metal objects can fall on the battery. An inadvertent short across such a powerful battery—a dropped wrench, perhaps?—will draw hundreds of amperes, melting, spraying molten metal about the shack, and possibly causing the battery to explode as arcs form, the metal glows white hot and hydrogen gas is ignited. Treat your battery with care and respect! A shorted battery may be permanently damaged even if it does not cause a catastrophe.

Conclusion

The power goes off. You look out the window. The entire area is dark. What happened? Is it local? Is it widespread? Is it a disaster, natural or manmade? Crank up the rig, using your battery backup power, and scan the ham bands. You will soon have the answer and be able to determine whether it is time to join an emergency net or whether some local event has caused the power outage. Either way, you can still operate for several hours and never have the slightest worry about TVI. RF

RF vintage review

The Heath HW-16 CW Transceiver

by Anthony R. Curtis K3RXK

If you're jaded with high power SSB operation and tired of short-range QSOs on the VHF bands, how can you put some life back into your hamming?

If you live in a tiny apartment and are putting most of your time into the intellectual pursuits on a university campus, what do you do to keep your operating hand in?

Revert to the womb, go back to the good old days, soak yourself in nostalgia and get your kicks—that's what you do.

Fix yourself up with a lower power CW transmitter, a reasonably sensitive and selective receiver, an old J-38, and a handful of crystals for various spots around the CW bands. Hook it all up to a decent antenna and you can be back in the swing of it in no time at all.

There's hardly anything easier to build than a QRP CW rig. Crystals are cheap. A J-38, or similar key, is easy to come by. And modern technology permits small, inexpensive receivers with excellent sensitivity and selectivity.

So, you get all set to put together just such a rig. You reach for the parts catalog and the Heathkit wish-book falls off the shelf. By coincidence, it flips open to the pages showing equipment designed for Novice operation. You decide to take a look at some Heath circuits. Maybe you can pirate a good idea for the transmitter you hope to build.

What's this? A three-band CW transceiver? With a price tag that won't cut into next semester's tuition? You pick up the book and take a closer look at the Heathkit HW-16.

The piece turns out to be a complete crystal-controlled transmitter and separate VFO-tuned receiver in a small, table-top package. The receiver tunes the first 250 kHz of 80, 40, and 15 meters. That means you can work 40 after classes in the afternoon; you can check into that 80 meter traffic net later in the evening; and you can start on a really challenging DX-CC on 15 meters.

Bandswitching is in one front-panel switch and transmitter tuning is simple. All you do is dip the final plate current reading on the front panel meter—or peak the power output reading on the meter, whichever you choose. There is a power level control on the front panel which lets you vary the screen voltage on the 6GE5 final, raising or lowering the input power of the transmitter. That way you can operate QRP or boost the rig's input to over 100 watts.

There are separate AF and RF gain controls on the front panel so you can operate the way you used to, running the AF gain wide open and adjusting the RF gain for listening level.

To keep operation simple, the only other controls Heath has put on the front panel are the large (1-3/4") main tuning knob (which has that important smooth and hefty feel) and two sizes of crystal sockets.

The key jack, speaker output jack, earphones jack (phono type), ground connector, VFO input jack, and VFO power output socket are all on the rear chassis apron.

Inside, the rig is quite simple and straightforward.

The transmitter uses a 6CL6 tube as a modified Pierce crystal oscillator and buffer amplifier. The signal from that stage is amplified by the second 6CL6, the driver. The driver stage functions as a tripler to 21 MHz for 15 meter operation. The final is a 6GE5 tube getting 600 volts from a voltage-doubler power supply. Low power transmitter and receiver sections receive 300 volts from the power supply. The primary of the power transformer is protected by a circuit breaker and turned ON/OFF by a switch on the AF gain control.

Grid-block keying controls the flow of cutoff bias to all three transmitter stages.

The front-panel meter measures a sample of RF output voltage at the antenna ("Rel Pwr") or final cathode current ("Plate").

Stray transmitter RF, which might tend to migrate toward the receiver sections, is kept out of the receiver's RF amplifier stage by bypassing to ground. A silicon diode, acting as an "antenna relay," is biased during transmit operation, permitting flow of current to ground only. During receive, the diode is unbiased and is effectively an open circuit at low received-signal voltages.

The pi network is used in both transmit and receive. Incoming signals follow a path through the receiver from the RF amplifier to a heterodyne mixer (with fixed-tuned heterodyne oscillator) to a VFO mixer (with manually-tuned VFO) to an IF amplifier, an xtal-controlled product detector, and two audio amplifiers.

The manual RF gain control varies the amount of cathode bias on the RF amplifier tube (6EW6). It also controls the cathode bias to the 6EW6 IF amplifier.

The heterodyne mixer is half of a 6EW6 and the heterodyne oscillator is the other half of that tube. The VFO and mixer share another 6EA8 tube. The VFO tunes 1900 kHz to 2150 kHz. The IF is at 3396 kHz. A 500 kHz crystal filter couples the VFO mixer output to the IF amplifier grid (6EW6).

One half of a 12AX7 tube is the BFO, crystal-controlled at 3396.4 kHz. The other half of that tube is the product detector which, produces an audio signal equal to the difference in frequency between the BFO and IF of the two input signals. The product detector output goes through the AF gain control to two halves of a 6HF8, twin-stage audio amplifier. The final audio is coupled through a transformer to either the speaker or headphones (the speaker is connected at all times). When the phones are plugged in, their high impedance mutes the speaker. There is a 2N1274 bias switch for receiver muting.

So, you consider a compact, three-band, crystal-controlled, good-looking transceiver, with full break-in and built-in sidetones so you can hear your own fist in the speaker or 'phones. You send in your check and the 20 pounds of gear comes by return mail. You unlimber the trusty soldering iron and spend a few hours wiring the rig. You make typically Heathkit-simple alignments. And you hook up a 50 ohm, unbalanced antenna.

Having gone through the thick and thin of ham radio for over 14 years, you need a vacation from building and testing weird, special-purpose antennas. You have little room for anything fancy. So, you invest in a Hy-Gain 18AVQ and relax (after pounding in four eight-foot ground rods).

You dig through the recesses of your apartment-sized junkbox-in-a-suitcase. Crystals at 3625 kHz, 7007 kHz, 7025 kHz, and 7044 kHz turn up. They will hit the three bands just right. The old J-38 code key comes out of the junkbox. A cotton swab makes a good cleaner for the key contacts and your old Novice call where it is scratched into the wood-block base.

You hook everything together and warm up the transceiver. Firing it up on 40, you call a W8 in Toledo. He comes back with an FB signal report. You tell him he's your first with a new Heath HW-16 CW Xcvr. He says your signals are loud and clear, despite strong QRM on the band. Later, you have a solid QSO with a W2 in New York and another with a W4 in Georgia, both on 80. The next morning you fire up for a quick check on 15 at mid-morning. It sounds as if all of eastern Europe is on the air, so you plunge right in, working three countries toward that new DXCC.

One of your hang-ups is contest operating—nothing hot-shot, just leisurely. Not the little contests, but the SS, VE/W, DX, FD, and the like. You check the calendar. The VE/W contest is coming up in a couple of weeks so you make the necessary arrangements with the XYL for a free weekend.

The contest weekend arrives and you knock off about 7,000 points with easy operating. You work all the Canadian geographical areas, save one. At three a.m. Sunday on 40 meters you connect with a 3C5/VE8 and you know the little rig is sweet. RF

Reprinted from the June 1968 issue of 73 Magazine.

Continued from page 1

converters legitimately intended for use with amateur transceivers, and for routine operation on the amateur 902-928 MHz band.

The League suggests that the proposed rule be clarified to assure that amateur access to the 902-928 MHz band is not unintentionally restricted by the unavailability of converter equipment. *TNX Westlink Report No. 645, March 18, 1993; ARRL.*

1993 SAREX Update

The following frequencies will be used for Shuttle Amateur Radio Experiment (SAREX) missions during 1993. These frequencies were chosen after much deliberation to minimize contention between SAREX operations and other 2 meter users. If you have any comments, please direct them to AMSAT via Frank Bauer KA3HDO (at his *Callbook* address or to the Educational Activities Department at ARRL Headquarters).

Most SAREX operations are split-frequency. One frequency is used for "downlink" (the astronauts transmit to earth stations) and a separate frequency is used for the "uplink" (earth stations transmit to the astronauts).

SAREX Voice Frequencies

The following frequencies are used for two-way voice communications with the shuttle astronauts.

Downlink, worldwide:	145.55 MHz
Uplinks, Europe:	144.70, 144.75, 144.80 MHz
Uplinks, rest of the world:	144.91, 144.93, 144.95, 144.97, 144.99 MHz

[Note: The crew will not favor any specific uplink frequency, so your ability to communicate with SAREX will be the "luck of the draw."]

SAREX Packet Frequencies

The following frequencies are used for packet communications with the shuttle.

Downlink:	145.55 MHz
Uplink:	144.49 MHz

For all operations, earth stations should listen to the downlink frequency and transmit only when the shuttle is in range and the astronauts are on the air. Listen for any instructions from the astronauts as to specific uplink frequencies in use during the current pass. In addition, listen to the uplink frequencies before transmitting to avoid interference to other users. *By Luck Hurder W1AW; TNX The ROMEG News, March 1993.*

Newcomers Grow by Another 5% in 1992 . . . Versus a 54% Increase in 1991

The final licensing statistics are in! Nearly 75% of all first-time ham operators chose the Code-Free Technician path into amateur radio during 1992. The Novice class continues to decline with 38% fewer beginners choosing this route than a year ago.

The number of beginners leaped by 53.8% in 1991 due to the establishment of no-code hamming. In 1992, there was a slight increase: 4.0% (44,748 vs. 42,660). *TNX W5YI Report, Vol. 15, Issue #4, February 15, 1993.*

Canadian No-Code

The Basic No-Code ham ticket came to Canada in late 1990. It was responsible for a 5.3% growth rate that year and another 10% in 1991. 1992's figures show an increase of 20% over 1991 through the third quarter! There are now about 35,000 ham licensees in Canada. (By comparison, there are 90,000 licensed hams in California alone!) Amateur license fees in Canada were also increased to $23 this year. *TNX W5YI Report, Vol. 15, Issue #3, February 1, 1993.*

RF

Training the Next Generation of Space Cadets

by Gary J. Shane WB5WOW and Bob Biekert KA5GLX

Over the past few years, we've heard a lot about the Shuttle Amateur Radio Experiment (SAREX) and how schoolchildren across the globe were able to talk to the ham astronauts in the shuttle. Most of their questions were intriguing and thought-provoking. What we haven't heard is what went on behind the scenes to enable these children to ask their questions. The Clear Lake Amateur Radio Club (CLARC) has recently completed coordination of a SAREX school contact during STS-50 and we'd like to share our experiences.

CLARC's SAREX Contact

We were contacted by John WD5EEV [president of the Johnson Space Center (JSC) Amateur Radio Club and technical representative for SAREX for the ARRL at JSC here in Houston] around the end of April 1992, asking us if our club would be interested in supporting the next SAREX mission contact with an elementary school in LaPorte, Texas. We were together when John called and quickly discussed the request while John waited on the phone. After a few seconds, we agreed the club would take on the project. But, now that we agreed, John needed the call of the ham who would be the control operator of the contact so he could get it into the flight documents for the mission. About that time Gary WB5WOW's 11-year-old daughter, Jennifer N5WFP, came down the stairs. We looked at each other and poof! N5WFP was volunteered. Jennifer had initiated her own youth net on the JSC 146.64 repeater a few months earlier and had been doing a great job acting as net control. John agreed that she would be able to handle this and we all thought it would be good for the schoolchildren as well.

The bomb dropped when we realized that within one month we would have to have the children selected, trained, and ready to go. To make matters worse, school would be out in three weeks! Not to be deterred, we arranged a meeting with the school principal and John for the next week.

In the interim, we discussed with John the technical details of how they had been handling the SAREX contacts the JSCARC Club had had in the past. The plan was to transmit on 440 MHz from the school using a 10-element yagi antenna pointed towards the JSCARC shack at the Johnson Space Center and then retransmit the signal on 145 MHz using their tracking antenna. The downlink signal would be received on 145 MHz and then rebroadcast on 440 MHz, through a 10-element yagi antenna, back to the school. A simple audio and PTT interface had been constructed for earlier SAREX contacts. It plugged into separate 2 meter and 440 MHz radios in the JSCARC shack. A switch was thrown manually when it was either the students' or the shuttle's time to transmit.

At our meeting, we were introduced to the science teacher, Mary Cummings, who would be working with us in this endeavour. We explained the program and what had to be done before the contact. We also surveyed the school for potential antenna sites and determined that we could use a 21-foot piece of chain link fence top rail to support a 6- or 10-element UHF beam. The next week (now the third week of May) Mary called us with the names of the children they had selected. Their decision was to select one child from each grade, kindergarten through fifth grade. We asked her to request that the parents have the children at the school on the following Wednesday at 4 p.m. so we could start familiarizing them with a radio and how to talk on it.

In the meantime, Gary created a two-page letter to send the parents, describing what their children had gotten themselves into and giving some background on SAREX, amateur radio, and CLARC. We also polled the club members for volunteers to help. Ruth Barrett AB5EI, Sandy Shane N5EOS, and Dick Wilkie N5SPU agreed to assist. The JSC club produced Gil Carmon WA5NOM, John Spear N5YCI, and Karen Nickel WD5EEU to assist from their end.

The next Wednesday (now the fourth week of May), the four of us met with the children, Mary, and a few of the parents. We explained what the SAREX program was, about amateur radio, and what we knew about the upcoming mission. We had secured handouts of crew pictures, mission decals, press kits, etc. to help keep the students interested. We also passed out ARRL literature on SAREX and CLARC newsletters, stressing amateur radio as well as the space aspect. We set up the Kenwood all-mode radio WD5EEV had loaned us with a mag mount UHF antenna and gathered the children around it. With Bob, Ruth, and Dick in another room on their HTs, playing the role of astronaut, we let the kids talk to them on simplex to get used to holding the microphone and speaking into it. Everyone had a lot of fun. By now the mission had slipped, much to our relief, to June 25th, so we had a brief respite.

Final Preparations

Now school was out and we were really curious to see who would make it to our weekly training sessions, if anyone. Well, every one of them returned and was more eager each time. Once we were comfortable that everyone had mastered the microphone, we moved on to including Jennifer and simulating the contact. With our own "astronauts," we ran through three simulated contacts each day we met. During the last two sessions, we timed how long it took to make the contact and go through one round of questions. John had warned us that, unlike normal SAREX missions in the past that had contacts that lasted eight to nine minutes, our contact would probably be only about four to five minutes. This was because of the unique attitude of the shuttle, due to the microgravity experiment onboard. So we made sure the student's questions were of a nature that would not elicit a three-to-five-minute response from the astronaut. This doesn't mean that we restricted the type of questions from the students; we encouraged them to come up with questions that were meaningful to them and wouldn't take a long time to answer. We also made sure that at the time of the contact the questions were memorized and typewritten in larger than normal letters. We strived to ensure that everyone would have at least one opportunity to speak with the astronaut. The simulated contacts were now lasting three minutes and 50 seconds.

During each practice session we had also been setting up the antenna outside and trying to make the link back to JSC. Each time the best we could do on signal strength was S5-S7 on JSC's end and S4-S5 on our end. John couldn't understand why this was so, and in checking the antennas and connections he found a broken coax connection at their end and repaired it. Now we had 60 over 9 signals!

Our last practice session with the children was on June 17th and we were thrown a curve ball by our third-grade student. John had just repaired the antenna and we decided to have him play "astronaut" and check out the link for real. When it was time for Cody to ask his question, he was so nervous he mumbled his question four times before John could understand him. Well, we about panicked. If he was this nervous talking to someone new who was on earth, what would he do when his turn came for the "real thing"? After the session, we talked to him and tried to make him understand that he needed to practice his questions and try to get over his mumbling. We all felt that everyone was ready, so we decided not to make them come back until the day of the contact.

On the evening preceding the big event, John came up to us at our Field Day dinner and explained that our contact would proba-

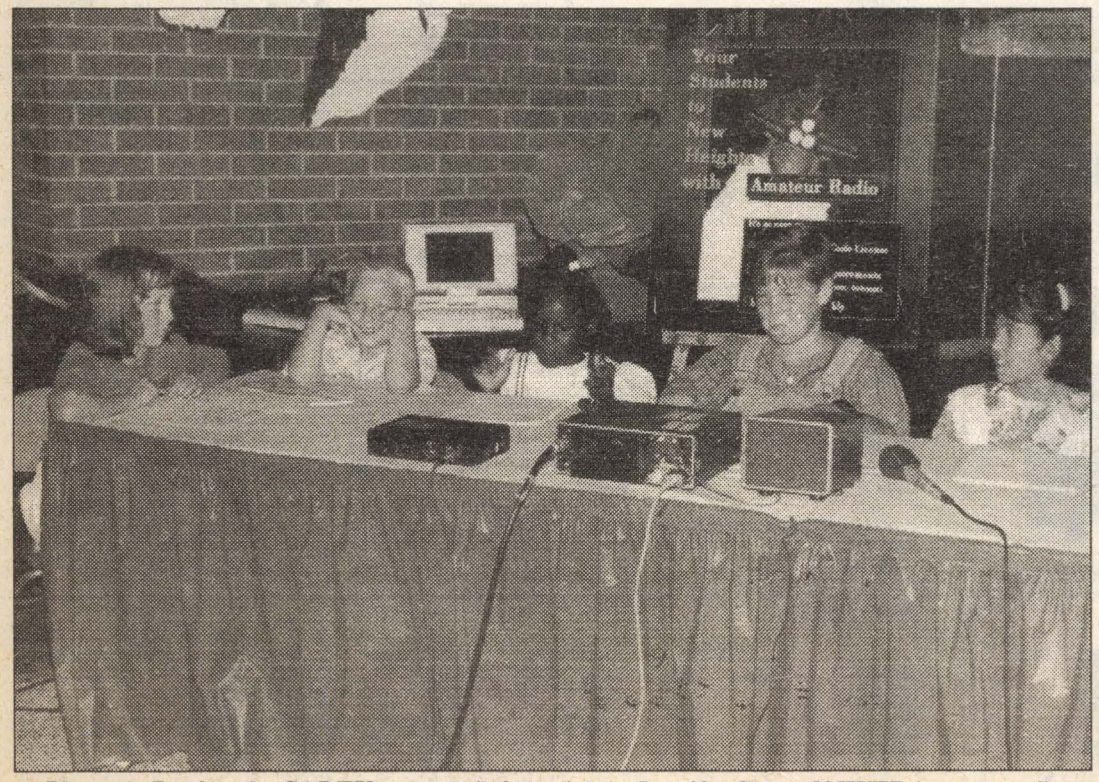

Photo A. During the SAREX contact (left to right): Jennifer Shane N5WFP (net control), Austin Hall, Ameiseka Nyaku, Cody Amundson, Rachael Benavides.

Photo B. First attempt to establish UHF link with W5RRR at NASA/JSC (left to right): Dick Wilkie N5SPU, Bob Biekert KA5GLX, Gary Shane WB5WOW, Ruth Barrett AB5EI.

◀ Photo C. Award assembly for SAREX students. Front row, left to right: Austin Hall, Cody Amundson, Rachael Benavides, Jeannette Bustillos, Cathy Lindsey, Amesika Nyaku. Back row, left to right: Gary Shane WB5WOW, Bob Biekert KA5GLX, Ruth Barrett AB5EI, Dick Wilkie N5SPU.

bly not work the next morning as they thought there were problems with the new antenna on-board the shuttle. They had had a successful test pass over JSC the first day in orbit, but contacts since then had not worked. We were devastated! We weren't sure what we were going to say to the children. Sorry just didn't seem to be enough. We had been warning them that it was an experiment and all, but when you're eight-to-10 years old, the ramifications of "experiment" just don't quite compute in your mind.

The Big Day

The next morning, after Dick and Gary had cooked breakfast for the Field Day and SAREX crews, we all picked up and drove to the school in a very somber mood. The school auditorium was decked out and the school staff had prepared breakfast goodies for everyone there. After setting up the antenna, coax, and checking signals and audio levels with JSC, we gathered the children together for a last-minute briefing and another "experiment" talk. Gary explained a little about what John had told us the night before, stopping short of telling them the pass probably was not going to work.

Our contact was scheduled for 9:59 a.m. CDT on Sunday, June 28th, and shortly before 9:30 a.m. the TV crews and newspaper photographers arrived en mass and began setting up equipment and camera flashes started going off. Bob had borrowed a portable PC from another CLARC member and it was set up on a table behind the children with a satellite tracking program running. The kindergarten student was fascinated with it and kept us posted on the progress of the shuttle across the Pacific Ocean. As the time approached, we all had assigned jobs to perform. Ruth was on the phone to JSC getting updates on the time to AOS (Acquisition of Signal), Gary was pacing the floor making sure radio knobs were set right, Bob was pacing and talking to the reporters at the same time, and Dick was in charge of picture-taking and muting the large-screen TV in the auditorium, which was tuned to NASA Select TV, receiving live downlink video from the shuttle. But now it was out of our hands. We had done our best and it was now up to the radio gods to make it work.

Then it was time! Ruth gave the signal to Jennifer to make the call. She spoke calmly and slowly, and it seemed like an eternity. Then she unkeyed. We're not sure how long we held

our breath, but suddenly KB5SIW's voice was coming out of the radio speaker, loud and clear. There was a collective gasp. We looked at each other and grinned, a lot.

The questions went up and the answers came down. It worked like clockwork. Even Cody only had to repeat a portion of his question! The photographers had now pressed to the front of the table across from the students, almost resting their cameras on it. There were flashes going off two feet from the students while they were trying to concentrate on asking their question! We were very concerned that this distraction would send them fleeing or cause questions to have to be repeated. Not to worry! The repetition we had put them through and their own "cool" paid off. The students acted like they were the only ones around and no one even as much as blinked!

We made it to the last student with four minutes elapsed and were still receiving *Columbia* 10/9. Gary motioned to Jennifer to get the microphone back to the first child to start the second round. On the answer to the second question of this round, KB5SIW's signal started to pick up quite a bit of static. Jennifer retrieved the mike and bid farewell to KB5SIW, thanking him for the contact and signing off with her call. We were amazed when KB5SIW returned her QRT and told the children he enjoyed the contact and said hello to the school principal. And then he signed off. Stunned, we asked Jennifer to make another attempt to contact the shuttle. But, he was gone as suddenly as he had appeared.

IT HAD WORKED! And worked like no other we've heard of, plus it lasted five minutes and 45 seconds! We were told later by the JSC SAREX group that it worked better than any other contact attempted during the STS-50 mission. We basked in our own good feelings for several minutes, watching the reporters flock over the children, taking pictures, interviewing them on camera, etc. John called on the link frequency from JSC and congratulated everyone and we also thanked them for their help. Yes, we did a few of our own interviews, but we're really not sure what we said. It probably wasn't very coherent, because we were all still in space.

"During the assembly the children's smiles and wide eyes were enough to tell us that they would never forget this event. It really was worth the effort."

Follow-Up

When the astronauts returned to Ellington Field in Houston after their mission, the SAREX team from CLARC and JSC was there to greet them. Jennifer made a sign that read "Welcome Back KB5SIW DE N5WFP" and Dick Richards spied it immediately upon exiting the aircraft. After their brief remarks, Dick greeted all of us and posed for pictures with Jennifer and the SAREX group. We had tried to get the students there as well, but most had scattered for family vacations after their contact.

Even though we had given the students numerous NASA trinkets and pictures, we still wanted to give them something special to remember this occasion. So Jennifer and Gary sat down and designed certificates for them and asked Dick Richards and the school principal to sign them. Since the contact occurred during the summer, none of the other students were aware of what had happened. So, the principal decided to hold an all-school assembly in October so we could recognize the students and volunteers. Our CLARC SAREX team (except for Jennifer who couldn't get out of her school) returned to College Park one more time for the assembly. We presented the six students with a certificate and a STS-50 crew picture autographed by every crew member, the principal with a certificate for the school listing the student's names and certificates to the school staff who had assisted us, and the science teacher with a certificate and a copy of *Now You're Talking* so she could study for her own ham license. The principal reciprocated and presented each of us with a College Park Elementary T-Shirt! We don't know how he knew that hams love T-shirts! During the assembly the children's smiles and wide eyes were enough to tell us that they would never forget this event. It really was worth the effort. That evening happened to be our CLARC meeting and president Kevin Biekert presented each CLARC SAREX team member with a certificate of appreciation as well.

It has been quite an experience working with the space program, even if it has only been from earth. Maybe someday they'll need someone to coordinate an earth pass. RF

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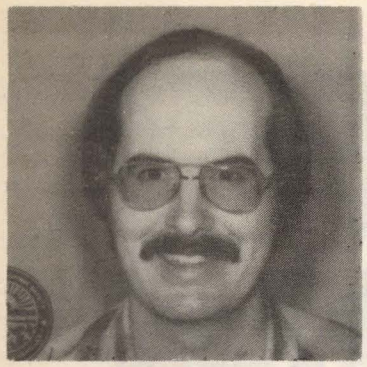


try something new

by Bill Brown WB8ELK

The Earthwinds Adventure

In the wee hours in the morning of January 13, Kim Cohan KD6TLB and I traversed a stormy Sierra Nevada range on our way to Stead Field airport in Reno, Nevada, to see the historic liftoff of the Earthwinds balloon. As we approached Donner Pass, the wind kicked up blasts of drifting snow, making travel difficult. Fortunately, Kim helped ease my fears with detailed stories of the ill-fated Donner party.

We finally arrived at the airfield at 4 a.m. and were transported to the Earthwinds launch site. There, rising out of the haze, was the majestic sight of a massive 180-foot-tall plastic balloon lit up with arc lamps. Since the temperature was a toasty 20 degrees *below* zero, every piece of equipment emitted an eerie cloud of steam and haze. Dozens of workers were assembling the cables to attach the various parts of the balloon system and inflating the top balloon from several semi-truckloads of helium. Another large balloon (the bottom ballast balloon) was also being inflated with air from a large blower. It looked like a government operation at an arctic base!

The Project

The Earthwinds Hilton project is designed to fly three balloonists non-stop around the world inside of a pressurized gondola. It will fly at 35,000 feet (in the jet stream) and should take two to three weeks to circumnavigate the globe. The unique thing about this balloon system is the use of two balloons. The top balloon (180 feet tall by 100 feet wide at liftoff) is filled with helium and has a capacity of 1.1 million cubic feet. The bottom balloon is 100 feet in diameter and is filled with air to act as a variable ballast. It is made of a special material called Spectra fiber (by Allied Signal) to allow it to withstand the high internal surface pressure which is necessary for the balloon to act as ballast. This unique two-balloon system should allow the Earthwinds balloon to fly for several weeks without throwing ballast overboard. The 15,000 lb. gondola (built by Burt Rutan, designer of the *Voyager* plane that flew non-stop around the world) is attached between the balloons. It's a very complicated system and requires hours of calm conditions during the inflation and launch process. Stead Field in Reno was chosen for the launch site because the winds in the area are low during the winter.

Of particular interest to amateur radio operators worldwide is the fact that the pilot of the Earthwinds balloon, Larry Newman, is amateur radio operator KB7JGM, and plans to operate a unique experiment on the 10 meter band during the flight.

The Ham Experiment

Designed by Bob Rau N8IYD of High Technology Flight, Jud Nichols N8RXT, and myself (WB8ELK), the ham experiment will take the data from a Rockwell Navcor GPS (Global Positioning System) satellite receiver, strip off the position data and convert it into a voice output. This is done using a High Technology Flight MCM4 microcontroller and a modified Elktronics voice ID. The final packaging and installation of the experiment in the gondola was performed by Jerry Knight WØWSN of Rockwell Collins. Information on this GPS to voice system can be obtained from High Technology Flight, 1450 Jeffery St., Ypsilanti MI 48198-6319; Tel: (313) 482-2670; and from Elktronics, 12536 Twp. Rd. 77, Findlay OH 45840; Tel: (419) 422-8206.

Every 15 minutes (or 30 minutes), the experiment's microcontroller will activate a Rockwell Collins transmitter (model HF-9000) on 28.303 MHz (100 watts USB) and transmit the following message (repeated two or three times each transmission): *"This is KB7JGM Earthwinds, XX degrees, XX.XX minutes North, XXX degrees, XX.XX minutes West (or East), XXX.X knots"*. Depending on available gondola power and the subsequent switch setting Larry chooses, this message will transmit every 15 minutes at 15, 30, 45 and 55 minutes past each hour, or every 30 minutes at 30 and 55 minutes. It is likely that the two-times-per-hour rate will be used during the majority of the flight.

It's hoped that, with this high power signal, the ham experiment will be received worldwide. For those who aren't in range of the signal, there will be relays of the telemetry after each transmission from a network of hams on the frequency who do copy the information. This will be a great opportunity for students who have access to ham stations at their schools to track the balloon on a map as it progresses around the globe. The 28.303 MHz frequency was chosen because it is the net frequency of the All School's net, which meets every Tuesday and Thursday at 12:30-1:30 p.m. Eastern time.

A Short Trip

This latest attempt on January 13 took about 10 hours from initial inflation of the top balloon to liftoff. Fortunately, the ground conditions were incredibly still due to a large temperature inversion. The final launch sequence proceeded very slowly as the gondola gently pulled over the ballast balloon with the use of long cables attached to several tow trucks' winches. When the gondola was about 50 feet in the air, a light breeze caused the system to twist around a couple of times. Anything more than a breeze would've proven very difficult for the launch crew. With morning temperatures hovering around 15 below zero, conditions were all the more difficult for the more than 200 volunteers preparing the balloon for liftoff. From my own experience, I can tell you that it is pretty much physically impossible to even change a roll of film at 15 below; I can well imagine how difficult it was to launch a balloon under those conditions!

At 10:13 a.m. the whole system raised a foot or two off of the ground, the tow truck

"Of particular interest to amateur radio operators worldwide is the fact that the pilot of the Earthwinds balloon, Larry Newman, is amateur radio operator KB7JGM, and plans to operate a unique experiment on the 10 meter band during the flight."

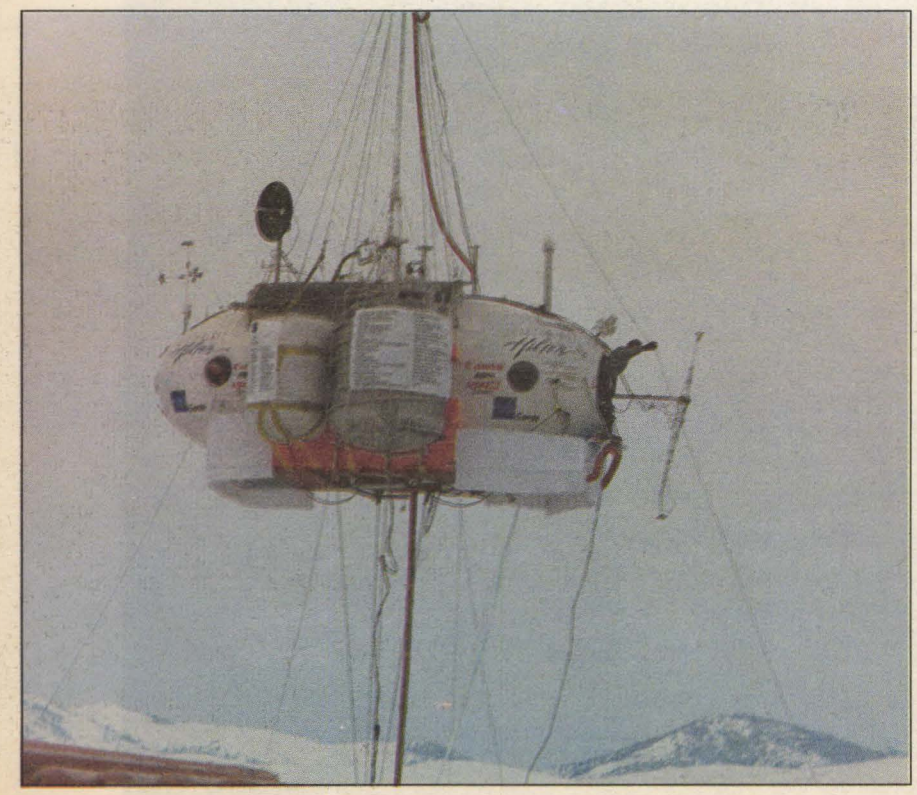


Photo A. The Earthwinds balloon takes off on January 13 from Reno, Nevada, for a short ride before hitting a mountain peak. Photo by Bill Brown WB8ELK.

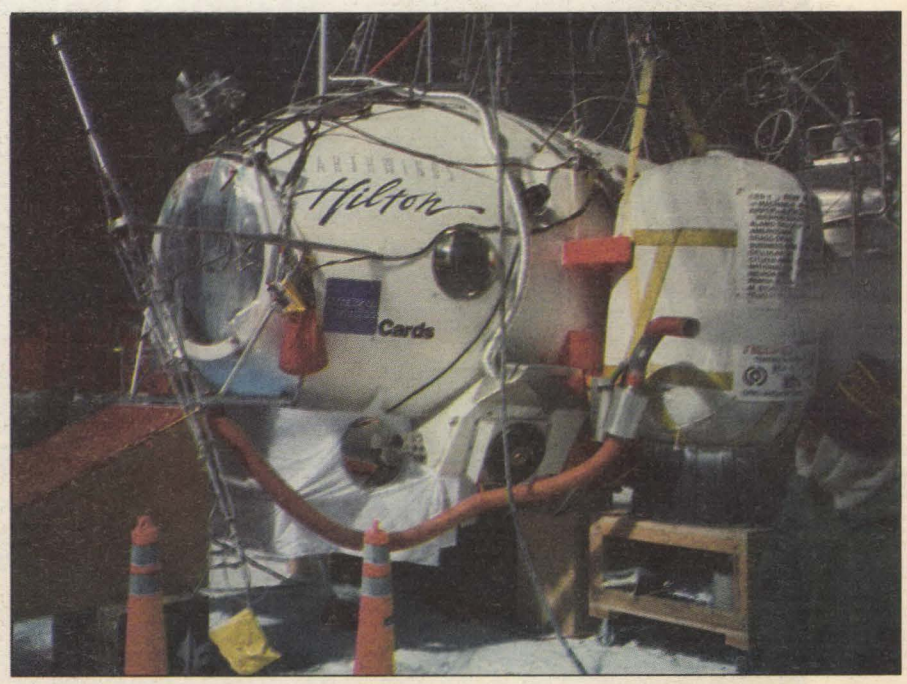


Photo B. A close-up view of the gondola showing the many wires and cables connecting it with the top and bottom balloons. Several tanks of liquid helium are attached to the side of the gondola to supply additional lift to the top balloon, if needed. Photo by Bill Brown WB8ELK.

advertiser index

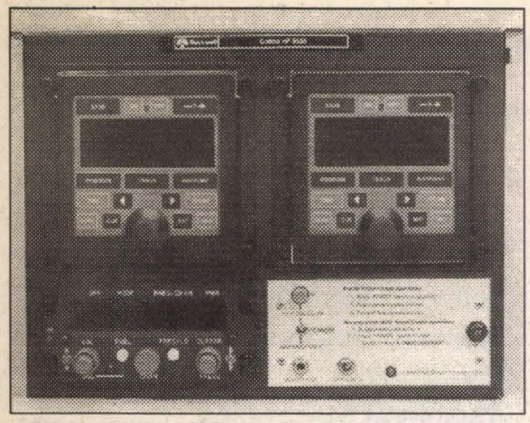


Photo C. The HF communications control panel. The ham experiment control box is located in the lower right of the panel. Photo by Jerry Knight WØWSN.

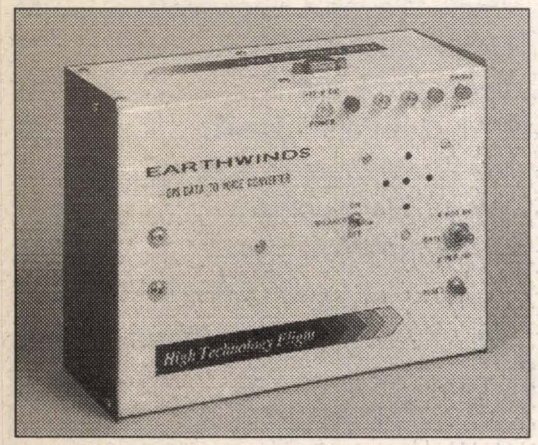
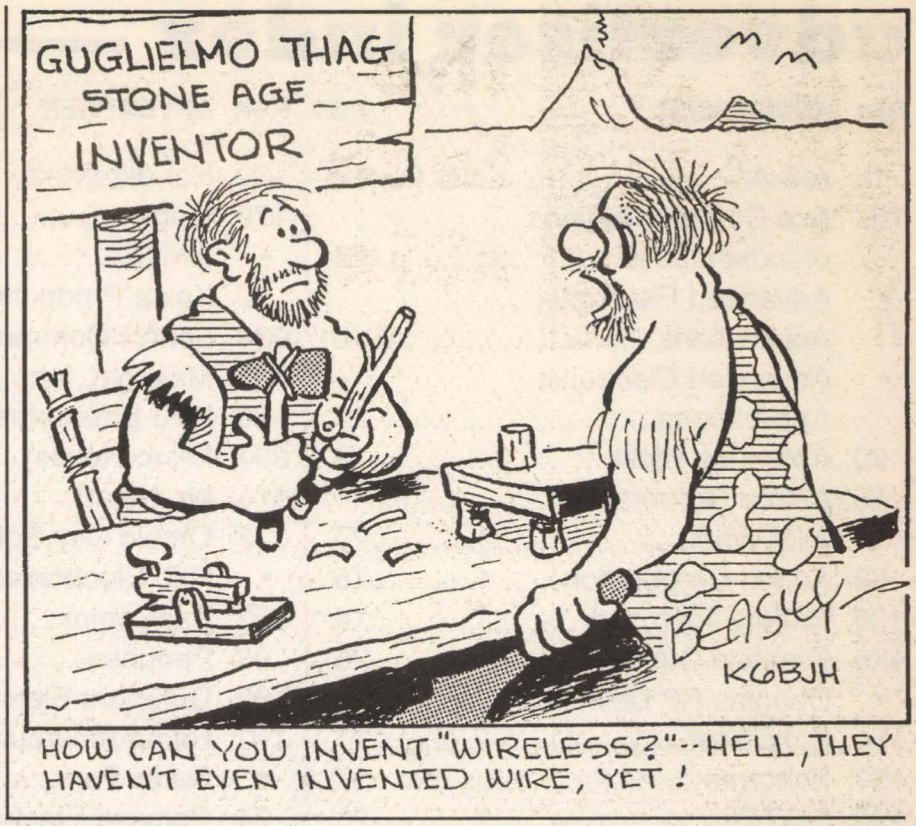


Photo D. The ham radio experiment will convert GPS data to a voice output. The latitude, longitude and ground speed of the balloon will be transmitted on 28.303 MHz USB every 15 or 30 minutes. Packaging and photo by Jerry Knight WØWSN of Rockwell Collins.

cables were jettisoned and the Earthwinds balloon finally took off! The 300-foot-tall balloon system rose very slowly into the hazy Nevada sky and a frosting of ice on top of the balloon could be seen reflecting the sun.

Everyone started celebrating the successful liftoff and rushed for warmth and shelter! A few of us braved the elements (and the risk of frostbite) and watched the very slow ascent. As the balloon headed northwest towards the highest peaks of the nearby Sierras, it seemed after a while that it had just stopped rising.

After about half an hour, I noticed the balloon approaching a mountain and saw it abruptly tilt at an odd angle. It soon disappeared behind the mountain. Listening in on the National Air Guard chase helicopter VHF frequency, I quickly heard the confirmation that the bottom balloon had hit the top of the mountain and torn open. Fortunately, the gondola and crew landed safely on a steep slope on the other side of the mountain. They had gone only six miles in their around-the-world flight and had landed just across the border in California! It appears that a 20-30 degree temperature inversion may have caused the balloon to lose its positive lift as it flew above the inversion. The crew dropped out a large quantity of ballast and even pumped extra helium into the top balloon. Unfortunately, they weren't able to counteract the lift deficiency and they hit the mountain.



The Next Attempt

The gondola was recovered with a helicopter and appears to have sustained only minor damage. Since a spare top balloon is already available, it is only necessary to obtain another ballast balloon. The time frame for optimum jet stream winds is from November through the end of February.

The next attempt is tentatively scheduled as early as November 15, 1993, from Stead Field in Reno. As the launch date approaches, look for announcements via the packet radio BBS network. Also, the ESPN network will be televising live coverage of the launch, along with periodic flight updates.

The 10 meter ham experiment will operate as before. During this last flight, one of the crew members, Russian cosmonaut Vladimir Dzhanibekov RV3DD, had planned to operate via 2 meter repeaters using an HT onboard the gondola. Although Vladimir has left the project, there is a chance that Larry KB7JGM may decide to operate 2m during the mission. RF

the tech side

by Michael Jay Geier KB1UM

Get the Picture!

For the last few months, we've been discussing the digital modes, from Morse code all the way through packet. I like to think of these methods of communicating as alternatives to voice. Sure, vocal communication is a human's most natural mode, but we also like to communicate with images. From cave drawings to modern art, humans have always loved to depict their thoughts, surroundings, etc. through pictures. So, although image transmission isn't necessarily a truly digital mode (although it can be), I like to think of it as yet another fascinating alternative to yacking into a mike.

Very few people in today's world are unaffected by television. From its earliest days, it has proven to be a powerful way to communicate. In fact, the ability to send a combination of pictures and sound over great distances may be one of the most potent advances of our entire civilization, soap operas notwithstanding.

So, it seems natural that we hams would want to play with TV. When commercial broadcasting began, any sort of video equipment was utterly out of reach to individual experimenters. But, just as with RTTY, surplus equipment eventually found its way into our hands and we were off and running! Today, of course, video gear is as commonplace as the TV itself. As a video-intrigued ham, you could not be luckier. Only 15 years ago, a black-and-white video recorder and companion camera weighed about 20 pounds and cost a couple of thousand dollars in "real" money. Color systems cost anywhere from $6,000 to $10,000 and weighed twice as much. The cameras needed ridiculous amounts of light and, often, the gear didn't even work very well. Today, it's darned near impossible to escape the $500 three-pound color camcorder. They're everywhere; I've even seen plenty of used ones being sold at hamfests! So, if you have one, why not put it to a new, exciting use?

Spectrally Speaking

There are several kinds of amateur image transmission. Let's start with the most familiar one: regular TV. Commercial TV operates in "real time." By that, I mean that the moving pictures and sound appear to occur as fast as normal life. While that is a very desirable goal, it has one serious drawback as far as ham radio is concerned: It takes a *lot* of spectrum space. When you got your license, you learned a little bit about bandwidth. In particular, you learned that SSB voice requires, and is by law limited to, 3 kilohertz. In fact, anything on the HF ham bands has the limitation that the audio it carries cannot occupy more than 3 kHz. Unfortunately, regular full-motion TV requires tremendously more space. In fact, normal commercial Vestigial Side Band (VSB) TV transmission (which is kind of like AM but has most of one sideband chopped off) takes 6 *megahertz*, and the video signal itself is over 4 MHz wide! Yikes, that's the equivalent of 2,000 SSB voice signals, and several times the available space in even the biggest HF band. And that's just for one signal! Obviously, it just can't be done that way on HF. Even if people would put up with one signal's hogging an entire band, it wouldn't be possible to make tuned circuits whose bandwidth was that big a percentage of their operating frequency.

Faster, Please

In fact, that's why commercial broadcasters use the VHF and UHF parts of the spectrum. As a total percentage of the operating frequency, the 6 MHz appears much smaller up there. And there's lots of room for plenty of stations. Hams do the same thing. There are several amateur TV (ATV) bands, starting with one at about 420 MHz and going on up into the gigahertz range. The method of transmission is exactly the same as the broadcasters use. Actually, there are two different types of ATV. "Normal" ATV, which most American hams use, is AM or VSB (which are pretty much compatible). There's a growing movement toward FM ATV, and it has a much stronger foothold in Europe than it does here. FM has several advantages over AM, including simpler equipment and longer operating distance. In fact, VCRs and satellite links use FM because of its resistance to noise and degradation. The main reason we hams use AM or VSB is historical, not technological: We started with surplus broadcasting equipment and have stayed with the old standards so that we could all see each other! As you know from watching regular TV, VHF and UHF frequencies normally do not travel over long distances. Except during very rare atmospheric disturbances, about 1.3 times the distance to the horizon is all you can expect. If you have a tall tower or a convenient mountain providing you with a nice, distant horizon, that can get you quite a way out. Still, you're never going to be seen in New Zealand. So, ATV basically is a local mode, like 2 meters.

Also like 2 meters, there are ATV repeaters. Yep, you can aim your signal at the repeater and have it retransmitted a great deal farther than you could get it out from your home. Yet even with the boost, it isn't likely to be seen hundreds of miles away. But, depending on where you live, there can be plenty of other ATVers within signal range. Especially if they went to the trouble of putting up a repeater, you can bet there's a group of ATVers just waiting to see your smiling face on their monitors.

What's It Take?

If you have a camcorder and TV set, you've got much of what you need to get on ATV. The other things required are a Technician or higher license and, of course, a transmitter and receiver! Oh yeah, a good antenna system, tuned for your operating frequency, helps a lot too. Because the transmitted energy is spread out over such a wide bandwidth, it takes plenty of signal to make a good picture, just like on commercial TV. Now you know why the UHF broadcasters have to run a million watts to cover a city. That's not an exaggeration, by the way—they really do run that kind of power.

Hams, of course, use much less power. Anywhere from one to 100 watts is typical. How do you get seen with such a small signal? Well, for one thing, good beam antennas can concentrate what power you have in the direction you want it to go. So, that old dipole with the 5:1 SWR won't do here. Luckily, antennas for these frequencies don't have to be large or expensive. Also, there are plenty available commercially, so you don't have to build your own.

Another factor which makes such low-power operation possible is the sensitivity of the other hams' receiving setups. Those beam antennas have the same concentrating effect on receive as they do on transmit. Also, most ATVers use a preamplified "down-converter" in their receivers. This device converts the incoming ATV signal to a regular TV channel they can tune in on an unmodified TV. The preamplifiers make the resulting system *much* more sensitive than a normal TV alone. So, it takes considerably less signal to make a good picture, although it still takes quite a bit more than it does for other modes.

Although early experimenters had to build their own equipment or modify surplus gear, today you can buy a ready-to-roll ATV transceiver. Typical prices are between $300 and $500. That'll get you from 1 to 10 watts of transmitter power, and a very decent down-converter. Plenty of hams have exactly such setups and have a ball with them. They show live video, and they also show camcorder tapes of vacations, friends, the last hamfest, whatever.

Sometimes Faster Isn't Better

So, you can see that ATV can be lots of fun. But how do you get your picture to someone halfway around the world? For that we use another kind of television. We call it Slow-Scan TV, or SSTV.

The basic idea behind SSTV is to take the normal TV signal and slow it way, way down in order to reduce its bandwidth to the acceptable 3 kHz. Believe it or not, you can do that, but it has a tremendous price: You can't send moving pictures. In fact, depending on the picture quality you desire, it can take anywhere from eight to more than 70 seconds for one frame! Is there any point to it? You bet there is! It is an absolute blast to watch your monitor screen fill up with the picture of someone who's speaking to you from 7,000 miles away. OK, you don't get to see him or her wave, but you still get the smile and the thrill of visual contact. Depending on the equipment you both have, the picture may be a crude black-and-white rendition or it may be a full-color, near-commercial-grade picture pretty close to what you see when your camcorder or VCR is in the "still frame" mode. I can tell you from experience that even the older, cruder equipment, which you can get for next to nothing at some hamfests, is quite a bit of fun. In fact, one of the most memorable experiences I have ever had in ham radio was when I exchanged pictures with a guy in Australia at about 3 a.m.

How Hard Is It?

It isn't hard to get into SSTV. In fact, if you already have an HF station, it's much easier than ATV because you can use your regular HF rig and antennas. Unlike with ATV, you don't need a special beam antenna. Because the SSTV signal has only a 3 kHz bandwidth, it is exactly like any other audio signal. In fact, it goes into your transmitter through the microphone jack and comes out the receiver through the headphone or audio out jack!

Of course, you can't just connect the video output of your camcorder to your HF rig. The super-fast video signal must first be converted down to audio. The device which does this is called a scan converter. It's kind of like a computer modem, only much more complicated. It captures and stores one frame of video and then reads it out slowly, turning the various spots of brightness and darkness which make up the picture into audio tones. When the other ham receives those tones, his scan converter builds up the picture bit by bit, displaying it on the TV as it comes in.

Doing all that requires a fair amount of digital circuitry. Until recently, a specialized box was required. Now, though, the proliferation of the personal computer has created another method of operating SSTV, and it is becoming quite popular. Next time, we'll explore SSTV in greater detail and discuss the various kinds of systems you can get. Until then, 73 from KB1UM. RF

radio magic

by Michael Bryce WB8VGE

I became a ham because I've always enjoyed building electronics projects. Getting my ham radio license just seemed to be the natural thing to do.

Everywhere I looked there seemed to be a new project to build. Perhaps a small receiver, a low power transmitter, or a legal limit amplifier, but they all kept the soldering iron hot for many an hour.

In the past several years, few hams have really wanted to (or could) build a multimode HF transceiver with all the bells and whistles. It's cheaper, faster and easier to just plunk down some money and walk away with a new piece of gear.

However, making contacts with the latest microprocessor-controlled Japanese radio will never give you the same feeling as the one you get with a small rig you built with your own hands. So, to correct this problem and to help start you down the road to home building, we have a simple project this month. It's a simple CW keyer, and I do mean simple.

Build Your Own CW Keyer

It will make self-completing dots and dashes. It's easy to build. There are no adjustments to make and you don't need a shop full of test gear to fix it. There are two CMOS chips on the board that are quite easy to find. The keyer runs on a 9 volt battery for a year; you don't even need a power switch! The keyer will work with all the new transceivers on the market. All the parts for the keyer mount on one small PC (printed circuit) board. The best part of all? Full kits are available for the keyer, including the PC board and all parts, for $15. You'll need to come up with a suitable enclosure to house your project, and we'll talk about that in a separate column. For right now, let's look at the keyer.

The schematic for the keyer is shown in Figure 1. As you can see, there's not much to it. Two ICs do all the timing and switching. A transistor switch is turned on by a gate from the chip and the key line is pulled low, keying the transmitter.

Whoa! Don't be afraid of the ICs. Many first-time builders instantly get turned off when they see an IC in a circuit. Relax! You won't need to know binary code, or memorize all the truth tables for every chip made. I can't remember them either and when I do need to know, I have to look them up.

Remember, there's a difference between not knowing and knowing where and how to look something up. If you consider an IC as just a black box, you'll be fine. Think of an IC as a black box with relays, or an amplifier, or transistor switch inside, and you'll not have a bit of trouble with "chips."

Both of the ICs used in this project are known as CMOS. That stands for Complementary-symmetry Metal-Oxide Semiconductor. This kind of IC is the most common type used today. In fact, you'll be hard pressed to find any other type being used. The older TTL ICs are still being made and you'll find them in older equipment, but they consume much more current than their CMOS brothers. CMOS chips aren't expensive and are generally easy to obtain. Radio Shack carries the more popular numbers in their stores.

Take a look at the schematic for our keyer. There's not much to it, only a clock and two flip/flops. The clock is the heart of our project. It consists of two gates, G1 and G3. The frequency of the clock, and thus the speed of the keyer, are controlled by two parts—the 470k pot (speed control) and the 0.1 µF capacitor. Changing either of these two will change the frequency of the clock and thus the speed of the keyer.

The output of the clock goes to the input of the first flip/flop. A flip/flop does exactly what the name implies. It flips one way, then when the second clock pulse comes along it flops the other way. The output of the flip/flop is on pin 2 of FF1. This goes to the input of the second flip/flop. One flip/flop will make dots and the other dashes, depending on which diode is on. And that is determined by the position of the paddle. If you push the paddle to the dot side, the output of one flip/flop will go to gate G4. Push the paddle the other way and the output from the second flip/flop will go to the same gate.

The 4011 CMOS chip is known as a NAND gate. To produce a high on its output, both inputs must be low. When both inputs are low, the chip's output goes +9 volts. That's how the transmitter is keyed. When gate G4 goes high it turns on the keying transistor via the 10k resistor. The transistor turns on and effectively shorts the transmitter's key line to ground, keying the rig. It's simple, cheap and dirty!

Soldering

Construction centers around the use of a PC board. You can build the keyer on perfboard if you wish, but unless you're already a builder with several projects under your belt, stick with the PC board.

The PC board is very small. It will take a steady hand with the soldering iron to prevent solder bridges. Let's consider this your first project and really go into detail while you build. This way, you're ensured of success when you apply power.

Before you start doing anything, check out the PC board. Look it over carefully for defects. Also, note the many traces and where two or more meet. Check between the IC pins for connections between the two. When you're soldering, it's easy to make a solder bridge between IC pins. But, if two pins are connected together, the connection will look like a solder bridge. By noting these now, you'll save some time and hair pulling later on.

Have you ever soldered before? It really is simple, but on the other hand, it's an art form that takes time to learn. If you don't have a good soldering iron, by all means pick one up. Don't get the cheapie ones from Radio Shack, either; they're not worth the money and will cause you all kinds of problems. Radio Shack does carry a good line of soldering iron, made by Ungar. You'll need a handle, a heat element and tips to complete the setup. Get a 23 watt heat element and a 33 watt element for heavy-duty soldering. A three-pack of soldering tips will give you one each of the following: needle, chisel and heavy-duty tips.

Of course, there are many, many different types of soldering irons on the market, and you should use the one you feel best with.

No matter what kind of iron you'll be using, a new tip requires a process known as "tinning." This is simple to do and involves heating up the tip and applying a coating of new solder to the tip. After you apply the

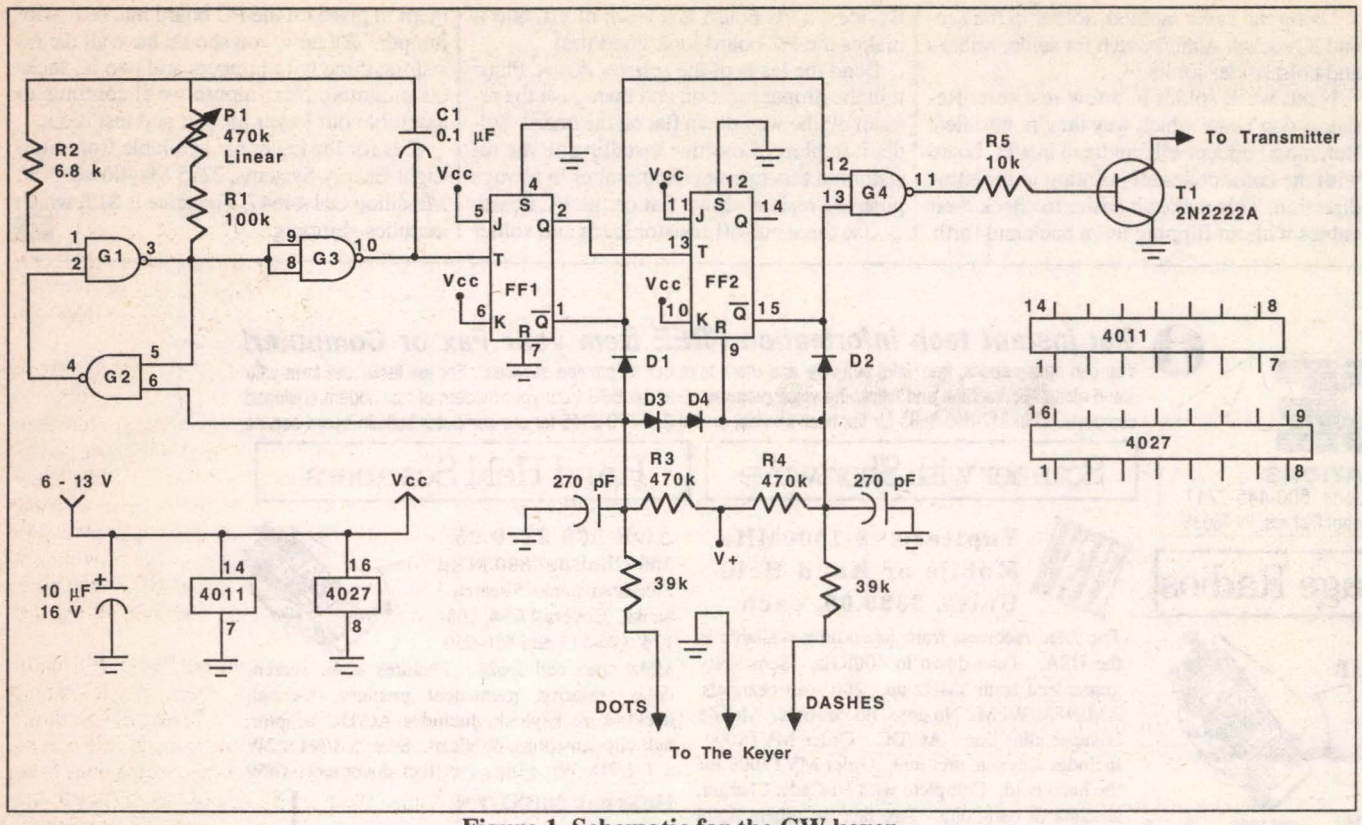


Figure 1. Schematic for the CW keyer.

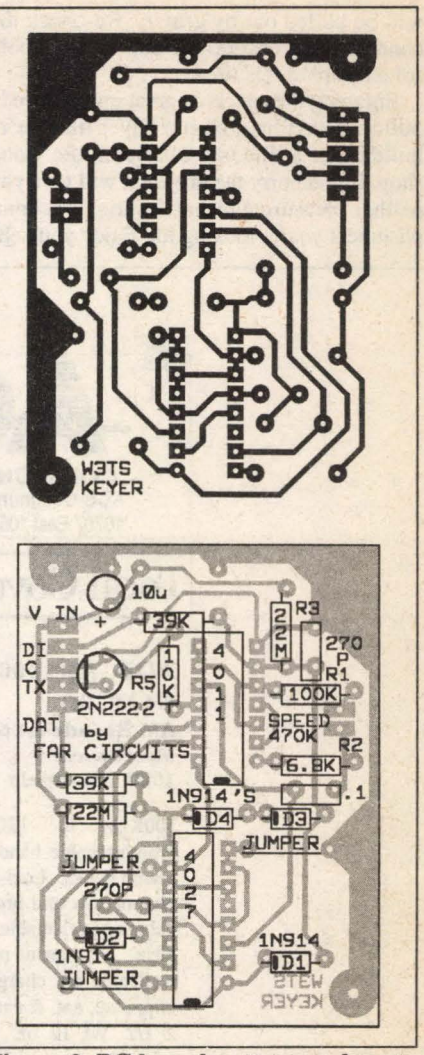


Figure 2. PC board pattern and parts placement for the CW keyer.

solder, let it cook for a few minutes and then apply a second coat. Wipe this coat off with a damp rag. The tip should now be shiny silver with the coating of new solder. You're now ready to start soldering on the PC board.

It's usually best to install the IC sockets first. This way, you won't place a resistor or other part in the IC's location.

Pick up a socket. Notice that it may have either a notch or a dot on one end. Although it makes no difference which way a socket is installed, it may cause confusion when installing the ICs later. Looking at the parts placement guide, you'll notice that both of the ICs have the notch pointing down. Install the first IC socket, a 16-pin socket, in the location marked 4027. Check to be sure all the pins are fully seated in the PC board and the notch or dot is pointing in the correct direction. Now, solder the socket in, but only on two pins, diagonal from each other. Flip the PC board over and double-check that you have the socket pushed down all the way on the board. Solder in the remainder of the pins.

It's a lot easier than it sounds. To solder in the socket, place the tip of the soldering iron against both the pin and the PC pad. The object in soldering is to heat up the joint and not the solder. The joint MUST be hot before you can apply solder to the connection. Hold the iron there for a second and then touch both with the solder. The solder will melt and connect the two together. Hold the iron for a split second after you remove the solder to heat the joint up again. Remove the tip and watch the joint cool. It should look shiny and metal-like when cool. If it looks like sand or is dull gray, you have what is known as a cold solder connection. The fix is simple: Reheat the joint and apply a bit more solder. Don't overdo the solder or you'll end up with a solder bridge. A solder bridge is exactly what the name implies: a connection between two different points on the PC board caused by a bridge of solder. The fix for this is almost as simple. Turn the board upside down and hold it in the air with one hand. With your other hand, apply the hot tip to the bridge and the excess solder

will be pulled out by gravity. Re-check the connection to ensure you don't have a cold solder joint at this time.

Enjoying the task is of great importance in building anything, be it a keyer like we're building or a fine oak cabinet in the wood shop. If you hurry the project it will give you neither pleasure nor that feeling of accomplishment you're looking for. Enjoy yourself!

Using the same method, solder in the second IC socket. Again, watch for solder bridges and cold solder joints.

Next, we'll solder in a few resistors. Resistors don't care which way they're installed. But, most builders will put them in a PC board with the color codes all pointing in the same direction. This makes it easier to check their values without flipping them back and forth. Besides, a PC board is a work of art, and it makes the PC board look good too!

Bend the leads of the resistor down. Place it in the proper location and then push the resistor all the way down flat on the board. Solder it in place. Continue installing all the resistors in this manner. Remember to always push the resistor down flat on the PC board.

Use three cut-off resistor leads and solder them in place on the PC board marked "wire jumper." By now, you should have all the resistors, three wire jumpers and two IC sockets mounted. Next month we'll continue to assemble our keyer project and test it out.

Kits for the keyer are available from Sun-Light Energy Systems, 2225 Mayflower NW, Massillon OH 44647. The price is $15, which includes shipping. RF

antennas, etc.

by Joseph J. Carr K4IPV

Dumping AM Broadcast Band Crud in the Receiver

Okay, so you get that SuperBandSniffer IV receiver, or that MegaLoudenBoomer transceiver, home and hook it up to the antenna, and what do you hear? Ham signals, of course. Or do you? An ideal ham receiver will hear only those signals that it's tuned to, but few receivers are ideal. Real receivers often respond to signals that they are NOT tuned to, especially when the offending transmitter is nearby. Of course, the higher the quality of the receiver, the less interference from out-of-band signals that it will suffer. But even some pretty decent receivers will occasionally suffer from this problem when too near a station.

The problem of AM Broadcast Band interference has been driven home to me several times over the past several decades. Once, many years ago, the late K4NFU was having a problem with a 780 kHz country music station, then called WARL (now WABS, and in a religious format). Johnnie lived about half a block from the station, and used a moderately priced Hammarlund HQ-110 receiver for his ham band activity. Being kids, we imposed ourselves on Steve Hart, who was then chief engineer (later he moved to WCMS-Norfolk). Steve showed us how to build a simple filter that would eradicate the AM Broadcast Band interference. That wasn't the only time that AM Broadcast Band interference got into the front end of a receiver in my orbit, and it won't be the last. So let's take a look at the phenomenon, and how to solve it in your own situation.

There are several mechanisms of interference. First, there is a problem called autorectification in which the amplitude modulated (AM) signal interferes with the audio stages of the receiver (a problem made worse by long speaker leads in receivers that use feedback to improve fidelity). The AM signal drives the first stage of the audio amplifier into a nonlinear condition, and that causes it to demodulate the signal. After all, it is little more than an envelope detector at that point. Perhaps more common on well-shielded ham receivers are two phenomenon at the antenna input of the receiver. One is desensitization, i.e. the strong AM Broadcast Band signal biases the RF amplifier of the receiver towards cut-off, and thereby reduces the gain. You might not even notice this problem, but it can easily occur. The other problem is harmonic generation in the receiver. Even if the transmitter is clean of harmonics (and it will be, or the engineer and licensee of the AM station is in deep do-do), the strong signal can drive the receiver RF amplifier (or any diodes across the antenna terminals) into nonlinear operation . . . causing harmonics of the AM signal to be generated. There are other problems as well, but you get the idea.

One Solution

There is a simple solution to these problems: Scrub the input signal to remove the offending, dirty, smelly, AM Broadcast Band signal. Get rid of it in the antenna circuit, which is why it's a fit topic for this column. Figure 1 shows a filter placed in the antenna line prior to the antenna input on the receiver. This configuration is easy to achieve on separate receivers, but a tad harder on transceivers. If you use a transceiver, there is a little warning in order: Either build the filter inside the cabinet and place it in solely the receiver antenna line (not always too easy), or build it for high power and place it in series with the low-pass filter that you use to eliminate your own harmonics.

Figure 2 shows a pair of simple high-pass filters (HPF) that will keep HF receivers in the 75/80 meters and up region from being whacked by AM Broadcast Band interference. These filters have a 3000 KHz cut-off frequency, and are intended for 50 ohm systems. Either port can be used for input or output because the filters are symmetrical. The model shown in Figure 2A is simpler (a "minimalist" approach), while that of Figure 2B has a higher rejection of the AM signal. A similar AM Broadcast Band rejection filter, although using different values, is given in *Radio Handbook,* 21st Edition, by Bill Orr W6SAI.

Another Approach

Another approach is to use an AM Broadcast Band bandstop filter, such as the one shown in Figure 3. This filter is designed to eliminate the AM Broadcast Band, while passing other frequencies. It is similar to the filter design given us kids many years ago by Steve Hart.

Regardless of which filter you select, if it's intended solely for receiver operation (and not for transceivers), then you can use small toroidal cores and wind your own coils. Alternatively, if you want to use fixed inductors, refer to any good electronics catalog, such as that of Ocean State Electronics [P.O. Box 1458, 6 Industrial Drive, Westerly, RI, 02891; phones 1-800-866-6626 (orders only), 401-596-3080, or 401-596-3590 (Fax only)].

Even Another Approach

Still another approach to solving this problem will work well on both receivers and transmitters: Use a good antenna tuning unit between the antenna and the transceiver. This approach has the charm of also matching the transmitter to the line. Even so-called "line flattener" ATUs—which are essentially tunable high-pass filters—will work wonders at squashing AM Broadcast Band crud before it gets into the receiver.

Book Note

By the way, one of my publishers has moved, and has also added an "800" number for credit card orders. HighText Publications is owned by Harry Helms and Carol Lewis. Their address is 125 North Acacia Avenue, Suite 110, Solana Beach CA 92075; phones 619-793-4141 and 4142. Credit card orders are handled by IPG at 1-800-888-4741. They publish my *Receiving Antenna Handbook* and *The Art of Science*, as well as Harry Helms books *All About Ham Radio* and *Shortwave Listening Guidebook*. They now claim to be the biggest technical publisher west of Pacific Coast Highway (or, is that the only publisher west of . . . ?), and to have sales greater than the combined profits of IBM and General Motors. Helms, you're dangerous. RF

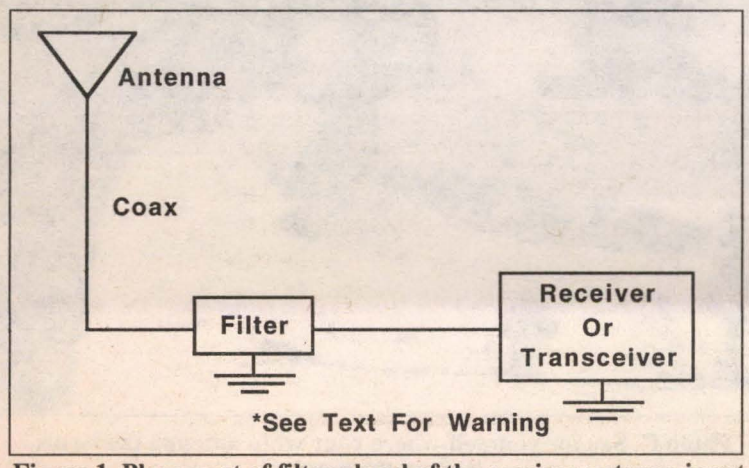


Figure 1. Placement of filter ahead of the receiver antenna input.

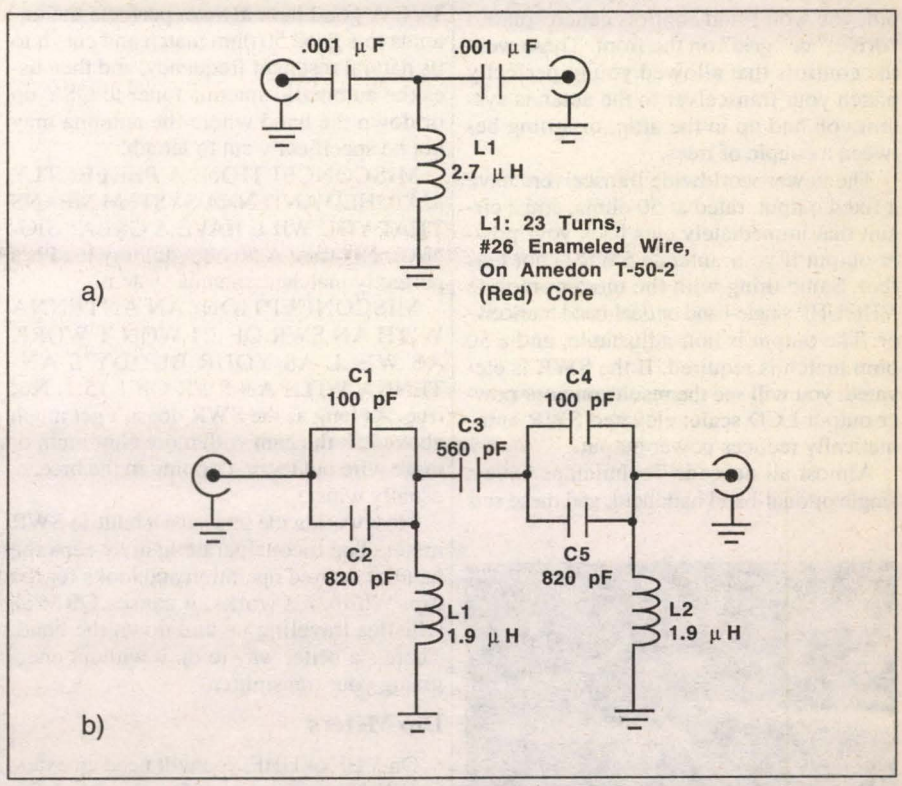


Figure 2. A) Simple 3 MHz high-pass filter. B) Two-stage version.

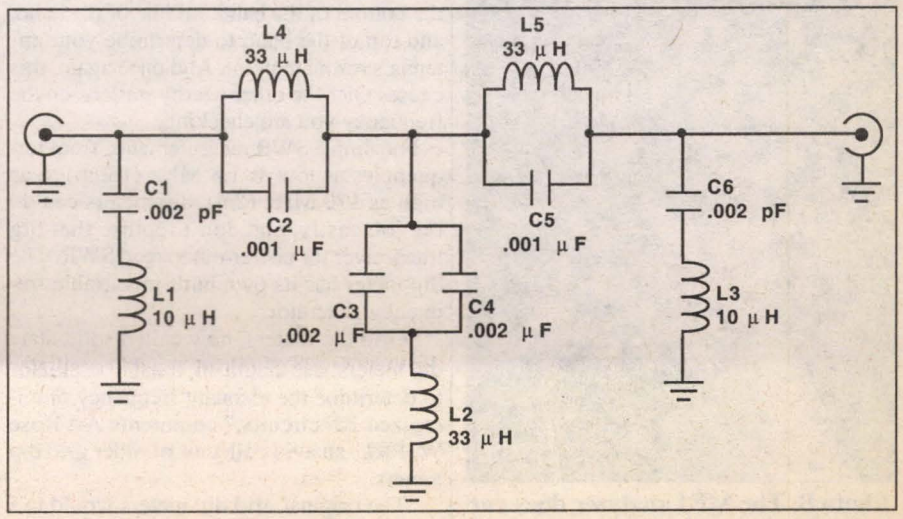


Figure 3. AM bandstop filter.

upgrade . . . don't stop now

by Gordon West WB6NOA

Learning Your SWRs

The modern ham set is extremely sensitive to the antenna system hooked up to its output antenna jack. On worldwide sets, the antenna output connector is called an "SO-239." On hand-held transceivers, the output connector is called a "BNC." And on dual-band mobile transceivers, many manufacturers provide a pigtail "SO-239" for the 2 meter side, and a pigtail "N-type" connector for the UHF circuit.

If you are a Technician-Plus operator, chances are you are active on the worldwide bands—10 meters for voice, data, and code; and 15 meters, 40 meters, and 80 meters for CW. If your transceiver is less than 10 years old, you won't find controls called "plate," "drive," or "grid" on the front. These were the controls that allowed you to perfectly match your transceiver to the antenna system you had up in the attic, or strung between a couple of trees.

The newer worldwide transceivers have a fixed output, rated at 50 ohms, and a circuit that immediately cuts back your power output if your antenna SWR is not perfect. Same thing with the modern mobile VHF/UHF single-band or dual-band transceiver: The output is non-adjustable, and a 50 ohm match is required. If the SWR is elevated, you will see the results on your power output LCD scale: elevated SWR automatically reduces power output.

Almost all no-code Technicians have a single or dual-band handheld, and these sets also offer only a fixed output. Most handhelds DO NOT have protective circuitry, so if the SWR is high they quickly get red-hot as they try to dissipate the mismatched antenna at the other end of the line.

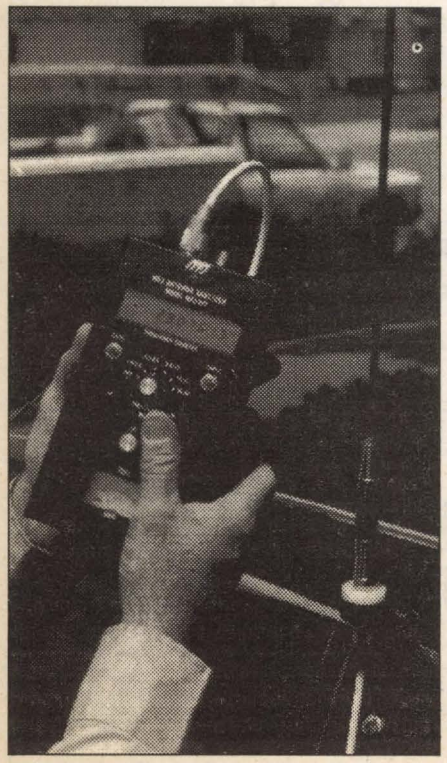


Photo B. The MFJ analyzer does *not* require a radio to make it work.

Worldwide sets with built-in automatic antenna tuners may minimize the apparent SWR of a lousy antenna system to the final output solid-state circuit within the set. This allows the set to once again operate at full power, but it in no way solves the problem with your less-than-perfect antenna at the other end of the circuit. You still have reduced antenna efficiency, and plenty of standing waves on the coax, all the way down to the rig, that will probably create horrendous TVI. A good ham always perfects the antenna to a good 50 ohm match and cuts it to its natural resonant frequency, and then uses the automatic antenna tuner to QSY up or down the band where the antenna may not be specifically cut to length.

MISCONCEPTION: A PERFECTLY MATCHED ANTENNA SYSTEM MEANS THAT YOU WILL HAVE A GREAT SIGNAL. Not true. A 50 ohm dummy load is a perfectly matched antenna system.

MISCONCEPTION: AN ANTENNA WITH AN SWR OF 2:1 WON'T WORK AS WELL AS YOUR BUDDY'S ANTENNA WITH AN SWR OF 1.15:1. Not true. As long as the SWR doesn't get much above 2:1, the ham with more aluminum or more wire out there, flapping in the breeze, usually wins.

Most worldwide sets have a built-in SWR meter. The inconsiderate ham sweeps the band of desired operation and looks for the dip. While this works, it causes QRM as whistles traveling up and down the band. There's a better way to do it without energizing your transmitter.

Dip Meters

On VHF or UHF, you will need an external SWR bridge specifically rated for VHF/UHF use, and a brief transmission at the bottom of the band, middle of the band, and top of the band to determine your antenna's resonant point. And once again, this causes QRM to other nearby stations on the frequency you are checking.

For simple SWR measurements, from frequencies as low as 1.8 MHz (160m) to as high as 170 MHz (2m), dip meters can do the job easily, and don't require that big transceiver for power-out to read SWR. The dip meter has its own built-in variable frequency generator.

"Grid dip meters, now called solid-state dip meters, use a built-in, tunable oscillator to determine the resonant frequency of energized RF circuits," comments Art Rose W1PXL, an avid collector of older grid dip meters.

"The original grid dip meters would use anywhere from five to seven plug-in coils, and on a dipole antenna it is easy to capacitively couple by holding the dip meter coil next to a temporary wire loop across the center insulator of the dipole," adds Art "the dipper man" Rose.

Art's collection of dip meters totals over 25 older units, and his collection is making way for a whole new style of checking antenna resonance, the HF/VHF SWR analyzer.

The SWR Analyzer

The SWR analyzer requires no external plug-in coils, but DOES require a connection to your antenna system's coaxial cable line. Like earlier "dippers," the SWR analyzer has a built-in signal generator, and may tune from 2 MHz to 170 MHz. A built-in frequency counter tracks the SWR analyzer's output for a quick check on where your signal generator output is. The output signal is in milliwatts and doesn't go much beyond the house next door.

An SWR meter remains pinned to the right until you hook in the coax and begin sweeping for your antenna's resonant point. And down on 80 meters and 40 meters that resonant point is tight! But the multi-turn tuning capacitor easily adjusts for minimum SWR, and you simply look up at the counter and see where your antenna is resonant.

If you swept your 64-foot (end to end) 40 meter dipole for Technician-Plus CW privileges, you might see the meter dip at 7000 kHz. This illustrates that your resonant point is low for Novice/Technician-Plus privileges between 7100-7150 kHz. Remembering "lower longer," you would slightly shorten each side of your dipole by two inches, and then sweep again to see where the resonant point is.

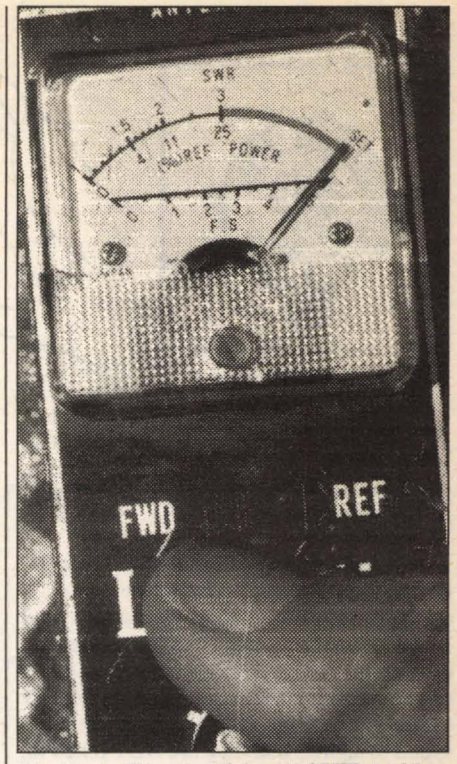


Photo A. The traditional SWR bridge requires the radio to transmit for a band, creating QRM.

If the meter dips at 7200, you shortened your dipole just a little too much, and you'll need to let out about 1 inch of wire on each side to get you back down between 7100-7150 kHz.

On the 10 meter band, a 16-foot dipole (end to end) should be relatively resonant from 28100 kHz to 29000 kHz. The higher in frequency you go, the greater the excursion for low SWR within the band.

Up at 2 meters, the SWR analyzer should show the needle beginning to dip at around 143 MHz, and then begin to rise again at about 149 MHz. This illustrates how you have the entire 2 meter band within resonance to your transceiver. However, if you are using an on-the-glass antenna, your resonant point will be rather sharp, and you will need to use your SWR analyzer to adjust that tiny little screw on the inside of your window's on-glass matching network.

If you are measuring the SWR of an antenna with an extremely long feedline, use Figure 1 (courtesy of MFJ) to calculate between the SWR indicated at the end of the coax and the true SWR at the antenna feedpoint. But as long as you

Photo C. See for yourself where your whip antenna performs best on the band.

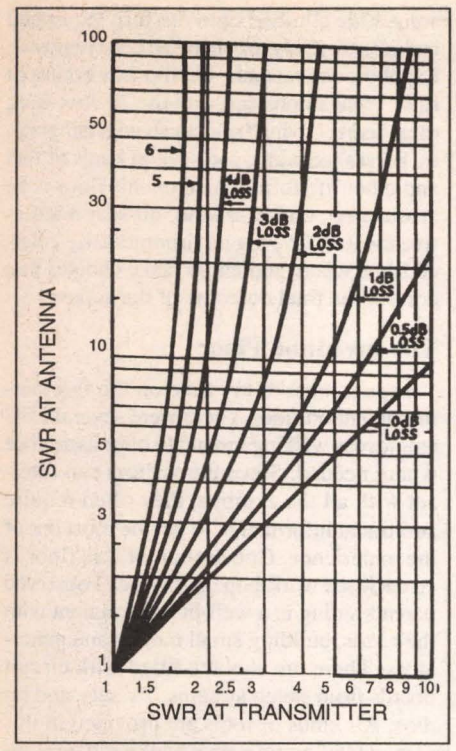


Figure 1. SWR at the transmitter vs. SWR at the antenna.

are lower than 2:1, your readings will be extremely close.

Get interested in antenna adjustments. Get the feel of antenna pruning or lengthening. Look what happens to SWR when your antenna is less than one-half wavelength off the ground. Use the SWR analyzer, or an older dip meter, to increase your skills in working with antennas without clobbering the band with your transmitter's powerful carrier. With an SWR analyzer, your signal won't go for more than about 100 feet, and will show you your antenna's resonant point with just a twist of the dial.

And if you don't find a resonant point, time to take a look and see what's going on at the other end of the feedline! RF

what's next

by Carole Perry WB2MGP

Liberty Science Center

On a snowy afternoon in February, I made my way down the New Jersey Turnpike to exit 14B in Jersey City, New Jersey. I was looking forward to my visit to the newly opened Liberty Science Center in Liberty State Park. Even through the snow that day I was impressed by the striking views of lower Manhattan, the Statue of Liberty and Ellis Island as I entered the Park area. I wasn't prepared for the awesome sight of the $67 million dollar Science Center that came into view.

The Liberty Science Center is the nation's newest hands-on center. The 170,000-square-foot facility features two signature design elements: The Kodak OMNI THEATER's geodesic globe, housing the world's largest OMNIMAX Theater, and the 170-foot observation tower. The exhibit space is divided into three distinct areas: Environment, Health, and Invention. "This is a primary learning center," says LSC president Charles H. Howarth, Jr., "where guests are encouraged to learn through doing and touching. We hope to act as a catalyst, providing the spark which will help every one of our visitors walk out the door wanting to know more about science." My tour guide was Elizabeth Graham, manager of public affairs. I explained to her that many of the science teachers at my school (Intermediate School 72, in Staten Island, NY) were eagerly awaiting my reactions to the LSC as a possible place for a field trip. What a place for a field trip this turned out to be! Elizabeth explained that LSC contains over 60,000 square feet of exhibition space on four floors, with more than 250 innovative and engaging "hands-on" exhibits, allowing visitors of all ages to experience firsthand the excitement of science and the satisfaction of individual discovery.

Original plans for the science center came about out of concern for a dwindling scientific literacy amongst many inner-city youngsters. For a long time, teachers have been searching for ways to stimulate curiosity and creativity in the sciences. In 1981, concerned about a lack of public awareness in the sciences and a decline in the numbers of qualified job applicants, members of the Research and Development Council, leaders of some of the state's largest scientifically-based corporations, began the long process of assembling an institution that will have a vital role in developing future generations of science-literate Americans.

Whenever I scout ahead, looking for stimulating places to bring my ham radio classes, I always look around to see just how many children are participating in the exhibits and whether or not they're having fun. Well, the LSC really fits the bill. As Elizabeth took me through this most unusual "learning place," she pointed out how much fun the youngsters who were there were having. All the electronics from each exhibit are exposed in clear plastic for the kids to look at. From the 90-foot-high atrium where I entered, I could observe children actually becoming part of the various exhibits and projects on all three levels.

In the atrium, art and engineering come together in a spectacular aluminum sphere designed by Chuck Hoberman that hangs high above the Invention Floor, unfolding robotically from a diameter of 4-1/2 feet to 18 feet in just seconds. The rear of the atrium features a colorful laser light display which projects up through the entire space. Even the escalators have the inner works visible through Plexiglas side panels, and the elevator is totally transparent.

My main interest was focused on the floor of Inventions, but I was thoroughly captivated by the innovative exhibits on the Health and Environment floors. The Health floor, for example, focuses on the human body and includes a Touch Tunnel, where visitors navigate a pitch-black maze using only tactile senses, and a perplexing 1,000-square-foot Illusion Labyrinth, with mirrors and optical illusions designed to challenge visual acumen. I could hear the squeals of delight as some kids climbed onto the fully equipped ambulance. (Only the siren had been removed, for obvious reasons.) On the Environment floor I was impressed with the 20-foot-long meandering "living" salt marsh with tall grasses, horseshoe crabs, and several kinds of fish and other life forms. Also on this floor is an astounding, one-of-a-kind, 60-seat interactive theater showing environmentally-related films where audiences make choices that control the final outcome of the action.

The Invention Floor

I spent most of my time on the fascinating Invention floor. There were several LSC employees walking around to offer assistance where needed. Since the visitors can interact with all the exhibits, they often require additional information to get the most out of the experience. One section of this floor is an enclosed workshop. In this area I observed parents sitting in a well-lit environment with their kids, building small motors and generators. There are shelves filled with circuit boards from stereo systems, TV sets, and radios. All kinds of tools are provided in this area, including reference books and well-informed personnel.

I was especially delighted to see the "swap" counter, where children can bring in electronic components from home and swap them for other objects in the showcase. It works on a points system. The better the child can explain about the item he is bringing in, the more points he earns towards the object he wants. I sat in this area for a while and just enjoyed the enthusiasm that came from the youngsters who were busy with their "inventions." The kids can build structures with the help of a 10-foot-tall electromagnet crane, or experiment with aerodynamics, gears and brakes. Also in the Workshop discovery room, ingenuity is encouraged in self-directed or guided activities creating "tools" using a mix of ordinary objects such as Popsicle sticks, scissors and hammers, and technical items such as computers and lasers.

Periodically throughout the day there are scheduled demonstrations conducted with small audiences. I caught the end of the demo on static electricity. It looked as though the youngsters were really enjoying it. The computers are strategically set up so invitingly that not one of them was sitting unused. I watched some children leave the demo area and run right over to the various computers to apply what they had just learned. It was wonderful!

I trailed behind a group of 7th grade visitors who went over to the Kodak OMNI THEATER area. This includes the most advanced motion picture projector ever built, which screens film at 300 feet per minute, or 20,000 feet per hour. The curved, 88-foot screen is complemented by a six-channel, four-way sound system. Kodak also offers visitors the opportunity to become part of the center's imagery through the use of a Kodak Image Magic system. The digital imaging system, which has enjoyed popularity at Walt Disney World, Universal Studios, and the Johnson Space Center, enables visitors to digitally add their likenesses into one or more of 10 different photographic settings, such as the Statue of Liberty's torch or the New York City skyline.

The Center's Goals

Elizabeth tells me that LSC is committed to exposing young people from all backgrounds to the sciences, encouraging them to explore careers in the field. A primary aim

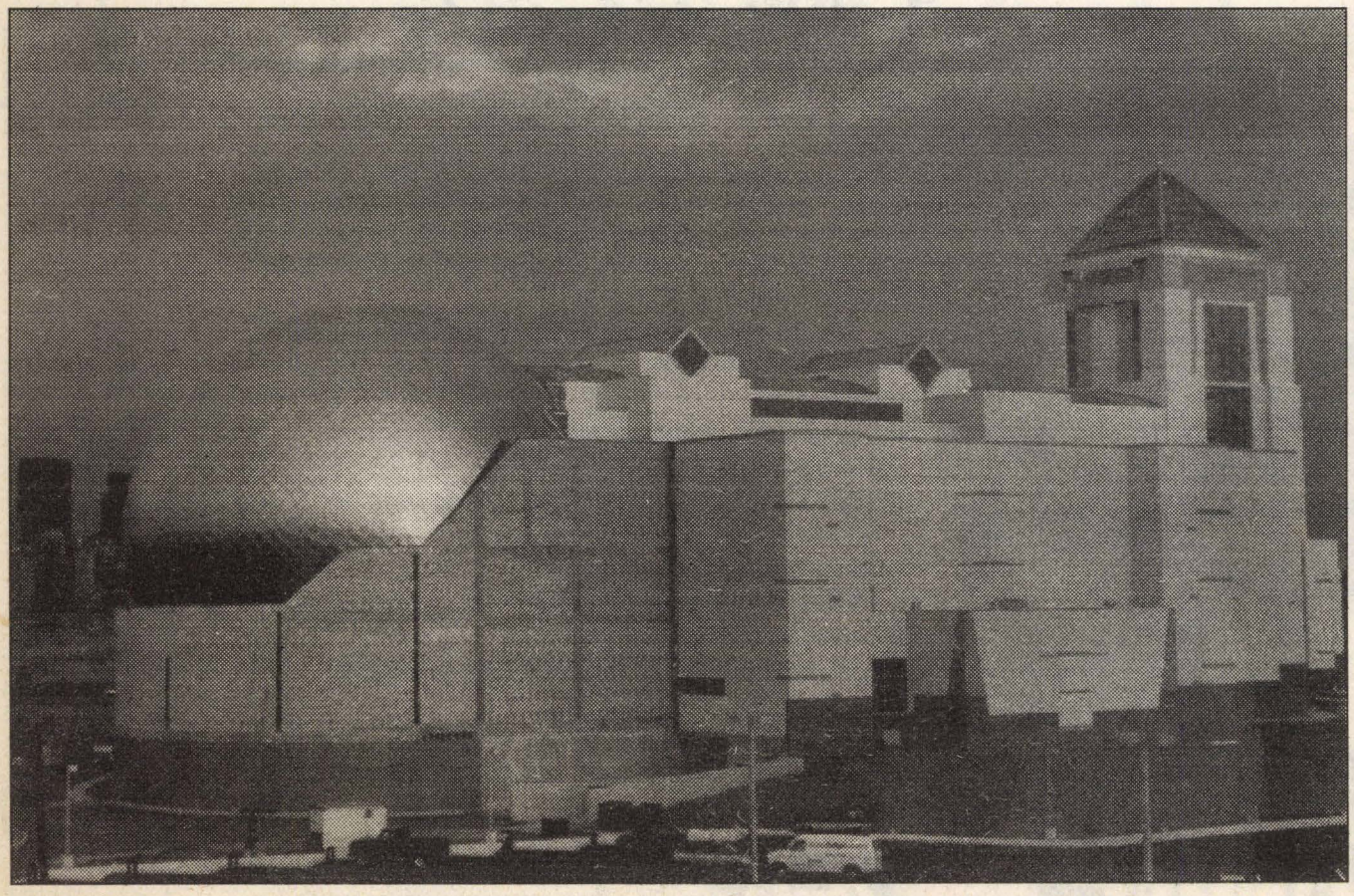


Photo A. Liberty Science Center, the nation's newest hands-on science center, is located in Liberty State Park, New Jersey, directly across from lower Manhattan and within view of the Statue of Liberty. The exhibit space is divided into three distinct areas: Environment, Health and Invention, where families discover the excitement, adventure and fun of science. The 170,000-square-foot facility features two signature design elements: The Kodak OMNI THEATER's geodesic globe housing the world's largest OMNIMAX Theater and the 170-foot observation tower. Photo by Eduardo Patino.

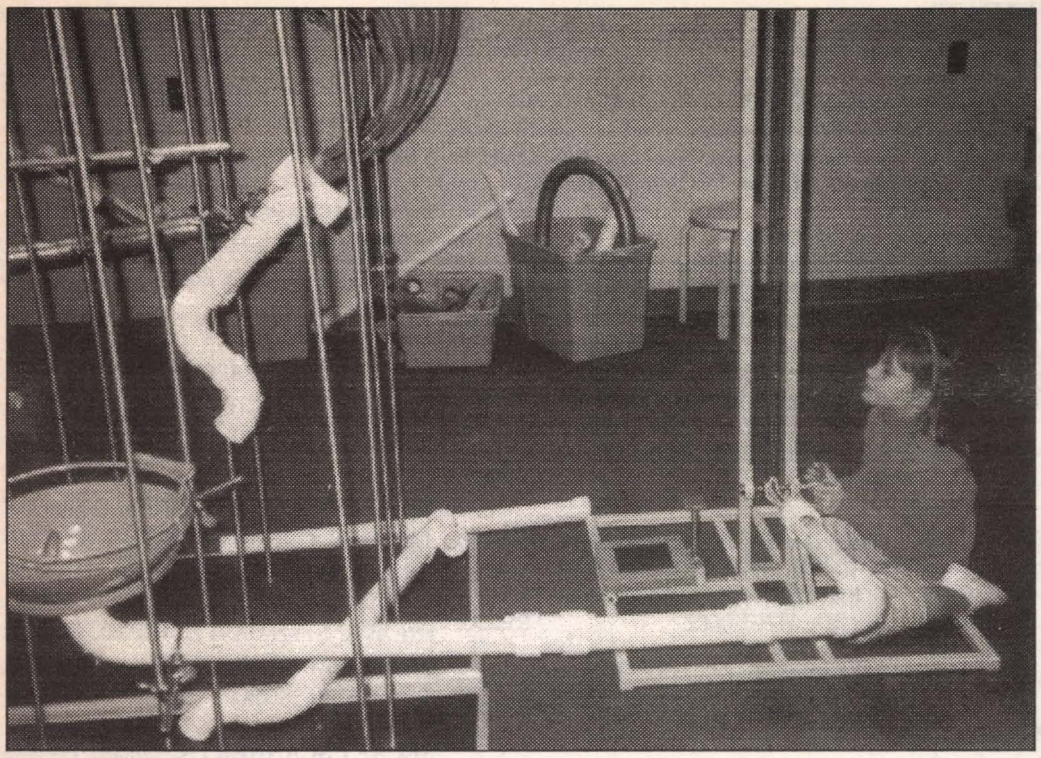


Photo B. Children can create their own Rube Goldbergs with the extensive arrays of materials.

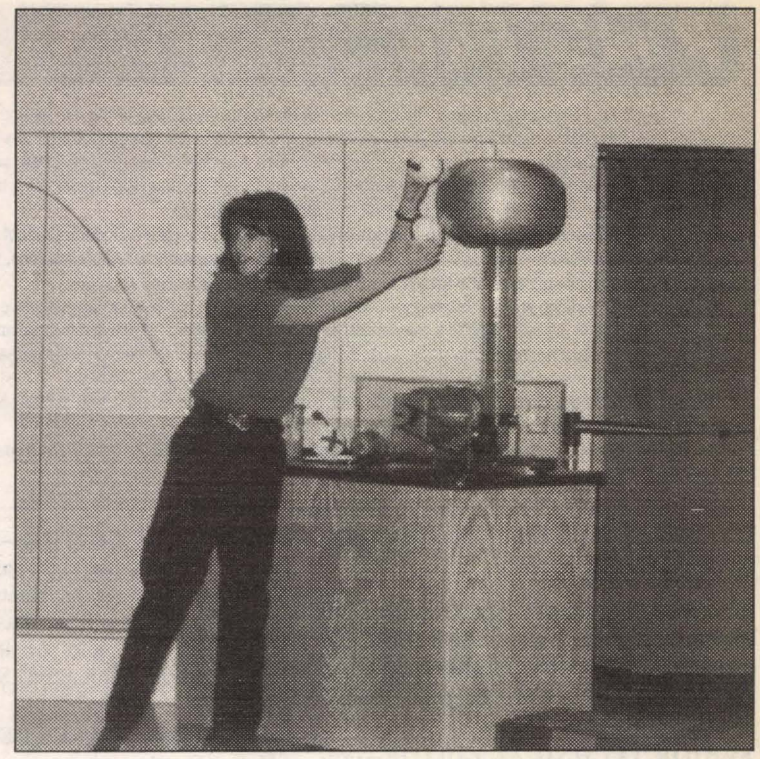


Photo C. Demonstrations on static electricity were a lot of fun for the kids.

is to reach and engage those students whose exposure to and interest in the sciences has traditionally been low, including women, minorities, and inner-city residents.

The institution is also involved in helping teachers make science curriculum more lively and relevant. The Education department, now in its fifth year of an extensive educational outreach program, has shown hundreds of teachers how to improve their science classes.

Initiated well before construction of the institution's building was even begun, other programs affecting hundreds of teachers, scientists and students annually include: "Science by Mail," a pen-pal program between children and scientists; "Partners in Science," in which professional scientists act as mentors to students on research projects; and "Science Design Partnership," where students have been invited to develop exhibitions for eventual display at the Center.

Private contributions and donations from more than 100 U.S. corporations help to support the Liberty Science Center.

For anyone living in the tri-state area, a trip to the Center is a must. For anyone who plans to visit the New York or New Jersey area, you should include a side trip to this amazing place. Make it a point to bring a child along for the fun. Plans are in the works for a ham radio station setup. If you are a ham radio operator, when you go there make sure to leave your suggestion for the value of a radio station with someone in administration RF

The Yaesu Manufacturing Co. has donated two 2 meter FT 26A2 transceivers to be given away as a door prize at Carole Perry's Youth Forums at Dayton, Ohio, in April, and at the Texas Ham Com in June.

One radio will be given to a youngster in attendance under 18 years of age at each forum.

Radio Fun flea market

Turn your old ham and computer gear into cash now. Sure, you can wait for a hamfest to try and dump it, but you know you'll get a far more realistic price if you have it out where 30,000 active ham potential buyers can see it, rather than the few hundred local hams who come by a flea market table. Check your attic, garage, cellar, and closet shelves and get cash for your ham and computer gear before it's too old to sell. You know you're not going to use it again, so why leave it for your widow to throw out? That stuff isn't getting any younger!

The *Radio Fun Flea Market* costs you peanuts (almost)—comes to 10 cents a word for individual (noncommercial) ads, and 70 cents a word for commercial ads. Don't plan on telling a long story. Use abbreviations, cram it in. But be honest. There are plenty of hams who love to fix things, so if it doesn't work, say so.

Make your list, count the words, including your call, address and phone number. Include a check or your credit card number and expiration. If you're placing a commercial ad, include an additional phone number, separate from your ad. This is a monthly magazine, not a daily newspaper, so figure a couple of months before the action starts; then be prepared. If you get too many calls, you priced it too low. If you don't get many calls, too high.

So get busy. Blow the dust off, check everything out, make sure it still works right, and maybe you can help make a ham newcomer or retired old-timer happy with that rig you're not using.

Send your ads and payment to *Radio Fun Flea Market*, Judy Walker, 70 Route 202 N, Peterborough NH 03458, and *get set for the phone calls.*

The Deadline for the June 1993 Flea Market is April 19, 1993.

HELP WANTED—EMPLOYMENT OPPORTUNITIES AT *73 AMATEUR RADIO TODAY/RADIO FUN*. The Publisher of this magazine is currently accepting resumes for the following positions:

SENIOR/TECHNICAL EDITOR—Responsible for editing of two magazines in the amateur radio hobby field, including evaluating manuscripts, assigning product reviews and technical editing. Requires a high degree of organization, teamwork and the ability to read and edit schematic diagrams and other material relating to radio communications and electronics. An amateur radio license is not necessary, but is a definite advantage. Salary Range: $20,000.

ASSOCIATE EDITOR—Entry level position, offering the right candidate a way of learning the magazine business. Excellent written language skills a must. Familiarity with electronics and an amateur radio license would be an asset. Salary Range: teens.

ADVERTISING SALES REPRESENTATIVE—Display advertising sales for the only magazine devoted to newcomers in the amateur radio hobby. Intensive customer contact over the telephone, with an emphasis on developing new accounts. Must be available for weekend travel approximately six times per year. An amateur radio license, while helpful, is not necessary. Salary Range: teens, plus commissions.

To be considered for any of these positions, send (no phone calls) your resume and cover letter to: **MR. D. CASSIDY, WGI,** 70 Route 202 North, Peterborough NH 03458. RF198

WANTED-External Power Supply for Palomar 300A Amplifier with 8 wire with 8 pin plug for back of amp. Good shape only. KB9FFB Harold, PO Box 264, Adams WI 53910. RF200

SPECIAL PRICES FOR RADIO FUN READERS—This month only! HR2600/HR2510 owners: add the 12 meter band to your radio with the easy to build plus 12 conversion kit, $25.00. Looking for the best code trainer program for your IBM compatable computer? IMCT 1-20 wmp, $10.00. Edward Oros, 2629 Sapling Dr., Allison Park PA 15101. RF205

FREE HAM TRADE/SELL/BUY SHEETS FOR THE NEW ENGLAND AREA. Send to: **EASTERN HAM PRESS,** Box N74, Westport MA 02790-0602. RF220

WANTED: External MAC 40M Drive—Repairable OK. (718)729-0714. Answering Machine. RF225

REPEATER FOR SALE. 2 meter Hamtronics, all accessories. Has all the bells and whistles. Will consider any offer over $765.00. Has been on the air only 2 hours and is 2 years old. I will have repeater codes changed and shipped to you. Call (800)484-2070 (Ext 4980). Pete N4UQS. RF240

SENSATIONAL NEW WAY TO LEARN CODE-Do Aerobics, Sing, Jog, or **Drive** while learning code! **Now** the secret is yours! Order **THE RHYTHM OF THE CODE-Morse** code music cassette today! $9.95 ppd **KAWA RECORDS,** P.O. Box 319-R, Weymouth MA 02188. RF247

MINIATURE POLICE RADAR TRANSMITTER one mile range, $41 assembled, $31 kit, (219)489-1711. P.O. Box 80096, Fort Wayne IN 46898. RF251

HOMEBREW COMPONENTS. Large SASE brings catalog. **KA7QJY COMPONENTS,** Box 3893, Logan UT 84323. RF271

WEATHER INSTRUMENTS. Digital and Traditional. Call for catalog. **THE WEATHER STATION.** (800)666-7014. RF280

INEXPENSIVE HAM EQUIPMENT. Send stamp for list. WA4DSO, 3037 Audrey Drive, Gastonia NC 28054. RF559

SECRET SCANNER Frequencies: Federal, Police, Aero, Military, Cellular, Surveillance, also SWL & CB Books. Big FREE catalog! **CRB RESEARCH,** Box 56-RF, Commack NY 11725. RF996

AMATEUR RADIO REPAIR!! All makes & models, average labor per unit, $96.00. **W7HBF, DAN RUPE,** 1302 S. Upland Dr., Camano WA 98292. (206)387-3558. RF999

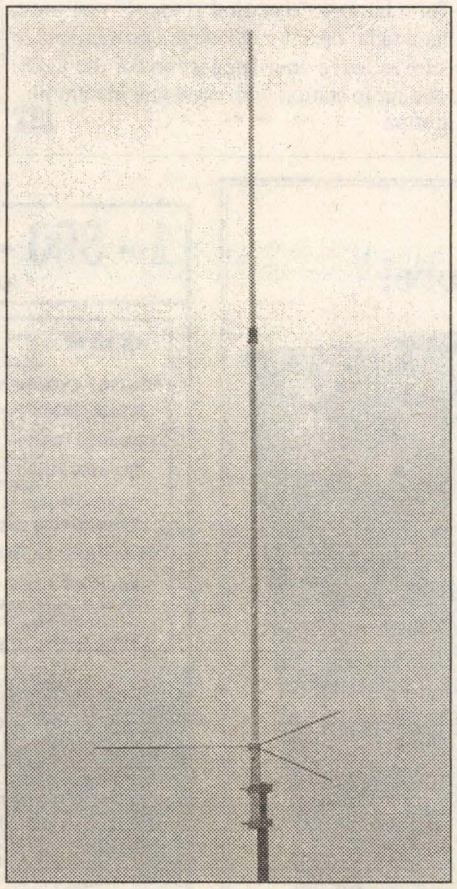
new products

NCG/COMET

The COMET Model CX-333 Triband Base/Repeater Antenna, covering the 2m/220/440 MHz bands, is now available from amateur radio dealers nationwide. The CX-33 is a two-piece white Fiberglas antenna with an ABS screw-together connecting joint and compression washer for complete waterproofing and easy assembly. The overall length is 10'4", with a gold-plated SO-239 connector.

COMET's exclusive SLC (Super Linear Converter) design is used to produce excellent gain of 6.5/7.8/9.0 dB. The SLC means that the internal element is arranged in a vertical coil, rather than a spring-type coil. This design produces higher gain and a pattern with a low angle of radiation. Additionally, each piece making up the element is soldered to the next, avoiding connections that could vibrate loose, or where corrosion could develop to attenuate the signal. As with all COMET antennas, it is completely pre-tuned and includes all mounting hardware.

For more information, contact *NCG, 1275 North Grove St., Anaheim CA 92806; (714) 630-4541, (800) 962-2611, Fax: (714) 630-7024.* Or circle Reader Service No. 203.



CM TECHNOLOGIES

CM Technologies has introduced a new packet radio software program for the Macintosh called *Savant*. Building on their previous success with *Virtuoso*, they have added a number of useful new features that make AX.25 packet operation on the Mac fast, easy and flexible. *Savant* offers a true Macintosh user interface, including scroll bars in session windows; an edit menu with undo, cut, copy and paste commands; and saving and printing of all or part of any session window. It also has a split window interface with both panes re-sizable. Animated icons and text fields in the session windows report the status of the connection: number of packets sent and outstanding, signal round-trip time, and number of retries. Multiple simultaneous connections are supported, each having its own window. *Virtuoso* has full-function digipeating capability and the option to assign an "alias" to your callsign.

For the price and more information, contact *CM Technologies, RR1 Box 83A, Kelley IA 50134; (515) 597-2051, CompuServe: 71574,421.* Or circle Reader Service No. 201.

W & W ASSOCIATES

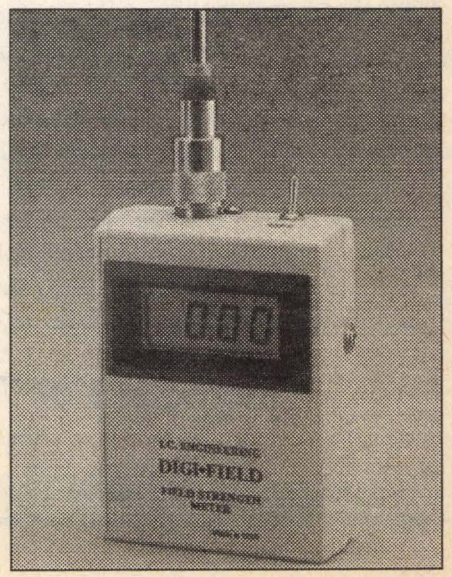
W & W Associates has introduced a new concept in two-way radio communications: rapid chargers (NiCd). With one charger you can change from a Motorola to a G.E. to an ICOM to a Yaesu, etc., radio by simply plugging in an appropriate adapter cup. The charger can charge any battery from 6V to 13.2V. The MasterCharger "I" utilizes a negative Delta V end-of-charge detection system with a Sanyo SI-101 microprocessor chip. The unit can also be used with a simple DC cord by just plugging the adapter cord into an automobile cigarette lighter receptacle. The MasterCharger "I" is manufactured in the USA.

For the price and more information, contact *W & W Associates, 29-11 Parsons Boulevard, Flushing NY 11354; (718) 961-2103, (800) 221-0732, Fax: (718) 461-1978.* Or circle Reader Service No. 202.

I C ENGINEERING

No more guessing about antenna performance comparisons. The new "DIGI-FIELD" from IC Engineering can be used as a sniffer for a 60-cycle noise source, as well as an intensity detector of microwave oven leakage, or an efficiency indicator of a cellular telephone. It has a 3-1/2 digit LCD display with a low battery indicator and uses a standard 9V battery. Its clear visual reading lets you make your own calibration for radiation gain or loss, antenna patterns, polarization, etc. It is designed to be used with its own telescopic antenna or an external antenna with a PL-259 connector. It also has a detector output jack for AM monitoring and other uses.

The DIGI-FIELD is priced at $119.95 plus $4.50 S & H. For more information, contact *I C Engineering, 16350 Ventura Blvd., Suite 125, Encino CA 91436; (818) 345-1692, (800) 343-5358, Fax: (818) 345-0517.* Or circle Reader Service No. 204.



Uncle Wayne's Bookshelf

BOOKS FOR BEGINNERS

02D42 **Digital Novice** *by Jim Grubbs* Geared to make you a more knowledgable participant. **$8.50**

01A87 **Shortwave Listener's Antenna Handbook** Primer antenna theory. **$13.95**

05C25 **Basic A.C. Circuits** A step-by-step approach for the beginning student. **$24.50**

05E50 **Fun Way Into Electronics** Exciting build and learn projects. **$9.95**

05E51 **One Evenings Electronic Projects** Easy inexpensive one evening projects. **$8.95**

20N018 **Technician Class License Manual: New No-Code** *by Gordon West* This book covers everything you need to become a Technician Class Ham. Every question and answer on the examinations is found in this one book. FCC Form 610 application. **$9.95**

20N092 **The Wonderful World of Ham Radio** *by Richard Skolnik, KB4LCS* Simple, clear, and fun. Introduces young people to amateur radio. **$7.95**

20N100 **Electronics Build and Learn (2nd Ed.)** *by RA Penfold* Combines theory and practice so that you can "learn by doing." **$12.50**

20N099 **Digital Electronics Projects for Beginners** *by Owen Bishop* Contains 12 digital electronics projects suitable for the beginner to build with the minimum of equipment. **$12.50**

AR2073 **Novice Antenna Notebook** A beginners guide to easy and effective antennas and tuners you can build. **$9.50**

AR2871 **W1FB's Help for New Hams** *by Doug DeMaw W1FB* Complete for the newcomer. Put together a station and get on the air. **$10.00**

AR2286 **First Steps in Radio** *by Doug DeMaw W1FB* Series of *QST* articles. **$5.00**

SHORTWAVE

06S57 **1993 Passport to World Band Radio** *by International Broadcasting Services, Ltd* You'll get the latest station and time grids. **$16.50**

03S11 **Shortwave Receivers Past and Present** *edited by Fred J. Osterman* Guide to 200+ shortwave receivers manufactured in the last 20 years. The Blue Book of shortwave radio value. **$8.95**

07R25 **The RTTY Listener** *by Fred Osterman* New and expanded. This specialized book compiles issues 1 through 25 of the *RTTY Listener Newsletter.* Contains up-to-date, hard-to-find information on advanced RTTY and FAX monitoring techniques and frequencies. **$19.95**

03C09 **Shortwave Clandestine Confidential** *by Gerry L. Dexter* Covers all clandestine broadcasting, country-by-country: tells frequencies, other unpublished information: spy, insurgents, freedom fighters, rebel, anarchist radio, secret radio. **$8.50**

03M221 **US Military Communications (Part 1)** US Military communication channels on shortwave. Covers frequencies, background on point-to-point frequencies for the Philippines, Japan and Korea, Indian and Pacific Oceans, and more. **$12.95**

03M222 **US Military Communications (Part2)** Covers US Coastguard, NASA, CAP, FAA, Dept. of Energy, Federal Emergency Management Agency, Disaster Communications, FCC, Dept. of Justice. From 14 KC to 9073 KC. **$12.95**

03M223 **US Military Communications (Part 3)** Completes the vast overall frequency list of US Military services, from 8993 KC to 27,944 KC. **$12.95**

09S42 **The Scanner Listener's Handbook** *by Edward Soomre N2BFF* Get the most out of your scanner radio. **$14.95**

03S208 **Radioteletype Press Broadcasts** *by Michael Schaay* Schedules of Press Services by time, frequency, and country broadcasting in English, French, German, Spanish, and Portuguese. **$12.95**

11T88 **Tune in on Telephone Calls** *by Tom Kneitel K2AES* Formatted as a frequency list with detailed description of each service and its location in RF spectrum. **$12.95**

03K205 **Guide to Radioteletype (RTTY) Stations** *by J. Klingenfuss* Updated book covers all RTTY stations from 3MHz-30MHz. Press, Military, Commercial, Meteo, PTTs, embassies, and more. **$12.95**

11AS10 **Air Scan Guide to Aeronautical Com-munications (5th Ed.)** *by Tom Kneitel K2AES* Most comprehensive guide to monitoring US aeronautical communications. Cover all Canadian land airports and seaplane bases, plus listings for Central America, the Caribbean, North Atlantic, and the Pacific Territories. **$14.95**

15A002 **Scanner and Shortwave Answer Book** *by Bob Grove* Most frequently asked questions by hobbyists. **$13.95**

07A66 **Aeronautical Communications Handbook** *by Robert E. Evans* Exhaustive, scholarly treatment of shortwave aeronautical listening. **$19.95**

07R20 **A Radio Journal 1912-1940** *by Russ Rennaker W9CRC* Easy to read and informative, educational and entertaining. A trip down memory lane to the early days of radio. **$7.95**

11RF13 **The "Top Secret" Registry of US Govern-ment Radio Frequencies (7th Ed.)** *by Tom Kneitel K2AES* This scanner directory has become the standard reference source for frequency and other important information relating to the communications of federal agencies. **$19.95**

11F52 **Ferrell's Confidential Frequency List, New Revised Edition** *compiled by A.G. Halligey* All frequencies from 4 MHz-28MHz covering ship, embassy, areo, Volmet, Interpol, numbers, Air Force One/Two, more. **$19.50**

11SR97 **National Directory of Survival Radio Frequencies** *by Tom Kneitel K2AES* Handy and concise reference guide to high interest communications frequencies required by survivalists. **$8.95**

11SM11 **Scanner Modification Handbook, Vol. 1** *by Bill Creek* provides straightforward step-by-step instructions for expanding the operating capabilities of VHF scanners. **$17.95**

11EE06 **Guide to Embassy Espionage Com-munications** *by Tom Kneitel K2AES* Candid and probing examination of worldwide embassy and (alleged) espionage communications systems and networks. **$10.95**

15D93 **1993 Shortwave Directory (8th Ed.)** *by Bob Grove* Extensively revised, the new 1993 Shortwave Directory is the consummate DXer's bible for the first 30 MHz of radio spectrum, including up-to-date and accurate. **$21.95**

20N093 **Vintage Radio 1887–1929** *by Morgan E. McMahon* The authoritative reference book for historians and collectors. **$8.95**

20N094 **A Flick of the Switch, 1930-1950** *by Morgan E. McMahon* Discover the fast-growing hobby of radio collecting. **$8.95**

07R26 **World Wide Aeronautical Communications** *by Robert E. Evans* Aircraft/Air Traffic Control, Aircraft/Company Operations, Aviation Weather Broadcasts, Aeronautical Flight Tests, Worldwide Military Air Forces, Aero Search & Rescue, Aero Law Enforcement, NASA Flight Support, Aero Terms & Abbreviations and Aero Tactical Identifiers. **$6.95**

11T89 **Scanner Modification Handbook Vol. 2** *by Bill Creek* Here it is—a companion to Vol. I. In fact, Vol. 2 has a section that provides improved approaches and updated techniques for the mods in Vol. 1. There's 18 new exciting modifications for popular scanners. **$17.95**

03R01 **World Press Services Frequencies (RTTY) New 5th Ed** A comprehensive manual covering radioteletype news monitoring—contains all information—antenna, receiving, terminal units, plus three extensive frequency lists. **$8.95**

ARRL BOOKS

AR1993 **ARRL 1993 Handbook (69th Ed.)** 39 chapters, featuring 2,100 tables, figures and charts. Comprehensive, well organized and affordable. **$25.00**

AR1086-4 **ARRL Operating Manual (4th Ed.)** Information on how to make the best use of your station, including: interfacing home computers. OSCAR, VHF-UHF. **$17.00**

AR0194 **Antenna Compendium Vol. 1** Materials on verticals, quads, loops, yagis, reduced size antennas, baluns, Smith Charts, antenna polarization. **$10.00**

AR2545 **Antenna Compendium Vol. 2** Covers verticals, yagis, quads, multiband and broadband systems, antenna selection. **$12.00**

AR4017 **Antenna Compendium Vol. 3** More verticals, yagis, quads, plus loops, arrays, mobile, direction finding, controlled currents, computerized, installation, overloads, plus 40 new articles for beginner's to advanced.. **$14.00**

AR2626 **Companion Software for Antenna Compendium Vol. 2** 5 1/4" MS-DOS floppy. **$10.00**

AR0488 **W1FB's Antenna Notebook** *by Doug DeMaw W1FB* Get the best performance out of unobtrusive wire antennas and verticals. Build tuners and SWR bridges. **$9.50**

AR0348 **QRP Notebook** *by Doug DeMaw W1FB* Presents construction projects for the QRP operator. **$9.50**

AR4141 **W1FB's Design Notebook** *by Doug DeMaw W1FB* Filled with simple practical projects that can be built using readily available components and common hand tools. **$10.00**

AR2200 **Antenna Impedance Matching** *by Wilfred N. Caron* Most comprehensive book written on using Smith Charts in solving impedance matching problems. **$15.00**

AR0402 **Solid State Design** Good basic information, circuit designs and applications: descriptions of receivers, transmitters, power supplies, and test equipment. **$12.00**

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AR2898 **Space Almanac** *by Anthony R. Curtis K3KXK* Recent news from space. **$20.00**

AR2083 **Complete DX'er (2nd Ed.)** *by Bob Locker W9KNI* Learn how to hunt DX and obtain hard-to-get QSL cards. **$12.00**

AR2065 **ARRL Antenna Book** The new 16th Edition represents the best and most highly regarded information on antenna fundamentals, transmission lines, design, and construction of wire antennas. **$20.00**

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REFERENCE

202101 **Everyday Electronics Data Book** *by Mike Tooley BA* A basic electronic "recipe" book using commonly available components. **$18.00**

20N102 **Practical Digital Electronics Handbook** *by Mike Tooley BA* Contains nine digital test gear projects. Digital circuits, logic gates, bistables and timers, microprocessors, memory and input/output devices. **$14.50**

20N103 **Electronic Power Supply Handbook** *by Ian R. Sinclair* Covers many types of supplies—batteries, simple AC supplies, switch mode supplies and inverters. **$16.25**

20N104 **Electronic Test Equipment Handbook** *by Steve Money* A guide to electronic test equipment for the engineer, technician, student and home enthusiast. **$18.00**

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02C30 **Commodore Ham's Companion** *by Jim Grubbs* Commodore computer and the Ham. **$9.50**

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09D22 **The World Ham Net Directory** *by Mike Witkowski* New—2nd edition. Introduces the special interest ham radio networks and shows you when and where you can tune them in. **$9.50**

09P33 **Pirate Radio Directory** *by George Zeller* Where to tune in on secret entertainment stations. **$7.95**

10F093 **1993 International Callbook** The new 1993 International Callbook lists 500,000+ licensed radio amateurs in the countries outside North America. It covers South America, Europe, Africa, Asia, and the Pacific area (exclusive of Hawaii and the U.S. possessions). **$29.95**

10D093 **1993 North American Callbook** The 1993 North American Callbook lists the calls, names, and address information for 500,000+ licensed radio amateurs in all countries of North America. **$29.95**

05H24 **Radio Handbook, 23rd Ed.** *by William I. Orr W6SAI* 840 pages of everything you wanted to know about radio communication. **$29.50**

02B10 **Heath Nostalgia** *by Terry Perdue K8TP* 124 page illustrated history of the Heath Company. Includes many fond memories contributed by longtime Heathkit employees. **$9.50**

10DF92 **1992 Callbook Supplement** An update to the 1992 International and American callbooks. **$10.00**

12E76 **Basic Electronics** *Prepared by the Bureau of Naval Personnel* Covers the important aspects of applied electronics and electronics communications. **$10.95**

12E41 **Second Level Basic Electronics** *Prepared by the Bureau of Naval Personnel* Sequel to Basic Electronics, thorough treatment of the more advanced levels of applied electronics. **$7.50**

01D45 **The Illustrated Dictionary of Electronics, 5th Ed** *by Rufus P. Turner and Stan Gibilisco* An exhaustive list of abbreviations, and appendices packed with schematic symbols and conversion tables. **$26.95**

20N091 **Most-Often-Needed Radio Diagrams and Servicing Information, 1926-1938, Volume One** *compiled by M.N. Beitman* An invaluable reference for anyone involved in Vintage Radio restoration. **$11.95**

20N096 **How To Read Schematics (4th Ed.)** *by Donald E. Herrington* Written for the beginner in electronics, but it also contains information valuable to the hobbyist and engineering technician. **$14.95**

20N097 **Radio Operator's World Atlas** *by Walt Stinson, W0CP* This is a compact (5x7), detailed, and comprehensive world atlas designed to be a constant desk top companion for radio operators. **$17.95**

20N098 **Electromagnetic Man** *by Cyril Smith and Simon Best* Health and hazard in the electrical environment. **$29.95**

20N020 **Secrets of RF Circuit Design** *by Joseph J. Carr* Written in clear non-technical language, covers everything from antennas to transistors. **$19.50**

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ED86751 Dumbing Us Down: The Hidden Curriculum Of Compulsory Schooling *by John Gatto* If you enjoyed "Declare War", you'll enjoy this also. A Wayne Green recommended reading. **$9.95.**

UHF/VHF PACKET

01P22-2 **The Packet Radio Handbook (2nd Ed.)** *by Jonathan L. Mayo KR3T* "...the definitive guide to amateur packet operation."—Gwyn Reedy W1BEL **Only $15.00**

09V11 **The Basic Guide to VHF/UHF Ham Radio** *by Edward M. Noll* Provides a first rate introduction to the 2.6 and 1.25 meter bands as well as 23, 33, and 70cm. **$6.50**

20N019 **U.S. Repeater Mapbook** *by William Smith N6MQS* The Guide for traveling radio amateurs. **$9.95**

03R02 **RTTY Today** *by Dave Ingram K4TWJ* Most comprehensive RTTY guide ever published. **$8.50**

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20N108 **The Easy Wire Antenna Handbook** *by Dave Ingram K4TWJ.* Gives you all of the needed dimensions for a full range of easy to build and erect "sky wires." **$9.50**

01A70 **Practical Antenna Handbook** *by Joseph J. Carr* Design, build, modify, and install your own antennas. **$21.50**

10A342 **All About Verticle Antennas** *by William Orr* Comprehensive coverage of amateur communications. **$10.50**

10A345 **Beam Antenna Handbook** *by William Orr and Stuart Cowan* Everything you need to know about beam design, construction, and operation. **$11.95**

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Advance	IBM04	COM04	$19.95
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IBM06, COM06 IBM/Commodore Tech No Code—Lanze Code Program Contains all the authorized FCC questions and answers used in testing formulas, schematic symbols, diagrams, and sample test for passing the new Technician No Code license. **$24.95**

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73T13 **"Back Breaker" $5.95**
13+ wpm—Code groups again, at a brisk 13+ wpm so you'll be really at ease when you sit down in front of a steely-eyed volunteer examiner who starts sending you plain language code at only 13 per.

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activities calendar

Send your announcements to: Radio Fun Activities Calendar, 70 Route 202-N, Peterborough NH 03458. We'll print as many as space allows, on a "first come-first listed" basis.

MAY 1

GLEN ELLEN, CA The Valley of the Moon ARC (WB6DWY) will hold its semi-annual Hamfest at the Sonoma Developmental Center, 15000 Arnold Dr., at McDougal Cottage, next to the fire station. Swapmeet, VE Exams, Ham and Egg Breakfast, SE Station, and more. Talk-in on 147.47 simplex and the 145.35 (-600) Rptr. For info call *Darrel WD6BOR, (707) 996-4494.*

MAY 2

SOUTH BEND, IN A Hamfest Swap & Shop will be held in PARKING GARAGE Downtown on U.S. 33 ONEWAY North by the Society Bank Bldg. and Century Center, across the street from Winter Hamfest. Talk-in on 52-52, 99-39, 69-09, 34-94, 145.29. Contact *Wayne Werts K9IXU, 1889 Riverside Dr., South Bend IN 46616. Tel. (219) 233-5307.*

MAY 3

ROCK SPRINGS, GA WCARS/VEC Exams will be held at Walker County (GA) Civic Center, US 27 Hwy., beginning at 7 PM. Pre-register with *Alan Painter WA4QCH, (404) 866-1200,* or *Dale Harwood N4VFF, (404) 937-5680.*

MAY 8

MANITOWOC, WI The Mancorad RC will hold its annual Hamfest beginning at 8 AM at the Manitowoc County Expo Ctr., intersection of Hwys. 42-151 and I-43 on Co. Hwy. R. Flea Market. VE Exams. Pre-register with SASE to *Moncorad RC, P.O. Box 204, Manitowoc WI 54221-0204.* For info, call *Red, (414) 684-9097 days,* or *Ron, (414) 793-4733 eves.*

MIDDLESBORO, KY Stop in at the Middlesboro City Library for WCARS/VEC Exams at 10 AM. To pre-register, contact *Andrew A. Pitt WB8WEZ, (606) 248-0046,* or *James E. Dyke KZ8A, (615) 869-4453.*

MURFREESBORO, TN The Middle Tenn. DX ARC will sponsor the Murfreesboro TN Hamfest from 8 AM-4 PM, indoors at the Rutherford County Agriculture Center, Old Fort Pkwy. (HWY 96); one mile east of I-24 Exit 78. ARRL sanctioned. Contact *Jerry Sartain KC4ALG, President MTDXARC. Tel. (615) 890-9358.*

MAY 8-9

AMARILLO, TX The Panhandle ARC will sponsor the Golden Spread Hamfest 8 AM-6 PM Sat., and 8 AM-2 PM Sun., at the Amarillo Civic Center, 3rd and Buchanan. Talk-in on 146.67 (-600). Contact *Lettie Hahn, (806) 358-7115.*

MAY 9

ATHENS, OH The Athens County ARA will hold its 14th annual Hamfest from 8 AM-3 PM at the City Rec. Center. To register in advance, contact *John Biddle WD8JLM, 80 Wonder Hills Dr., Athens OH 45701. Tel. (614) 594-8901 after 6 PM.* Talk-in on club repeater at 145.15+ MHz. For general info, write to *Carl J. Denbow KA8JXG, 63 Morris Ave., Athens OH 45701-1939.*

MAY 14-16

TULSA, OK The 1993 Green Country Hamfest and ARRL Oklahoma Section Convention will be held at the Maxwell Convention Center, W. 7th St., between Denver and Houston Aves. VE Exams. Talk-in on 146.28/.88. Call *(918) 272-3081,* or write *P.O. Box 470132, Tulsa OK 74147-0132,* for info. Sponsored by Green Country Hamfest Inc.

MAY 15

AMENIA, NY A Hamfest sponsored by the Southern Berkshire ARC will be held from 8 AM-2 PM at the Amenia Firehouse on Mechanic St. Talk-in on 147.285+. Contact *WB1CEI, (203) 364-5266* or *N1GIS, (203) 364-5976.*

CADILLAC, MI The Wexaukee ARC will hold its annual Swap 'N Shop and Eyeball QSO at the Cadillac Middle School starting at 8 AM. Talk-in on 146.98 Rptr. Contact *Wexaukee ARC, P.O. Box 163, Cadillac MI 49601,* or call *Dan Schmidt KE8KU, (616) 775-0998.*

COLORADO SPRINGS, CO A Ham Radio/Computer Swapfest will be held by the Pikes Peak RAS, from 8 AM-4 PM at the City Auditorium, 221 E. Kiowa at the corner of Weber St. Talk-in on 146.97/.52. For general info, call *Doug Paris N4TGO, (719) 495-9346.* VE Testing 9 AM-1 PM; call *Rick Brown KD0SU, (719) 531-9423* for details. To reserve tables, contact *Dennis Ochs N7OGL, 850 Santa Fe St., Colorado Springs CO 80903. Tel. (719) 630-0704.*

CROSSETT, AR A Hamfest & Crafts show will be held from 8 AM-4 PM at the Nat'l Guard Armory on Bus Route 133, Florida St. Sponsored by the Southeast Arkansas ARC. VE Exams at 10 AM. Talk-in on 146.04/.64. Contact *Ray Haney, 1707 S. Louisiana, Crossett AR 71635. Tel. (501) 364-5957 eves.*

N. SMITHFIELD, RI The R.I. Amateur FM Rptr. Serv., Inc., will hold their annual Spring Auction & Flea Market starting at 8 AM at the VFW Post 6342, Main St., in Forestdale. The Auction will be from 11 AM-3 PM. Talk-in on 146.76. Contact *Rick Fairweather K1KYI, 106 Chaplin St., Pawtucket RI 02861. Tel. (401) 725-7507 between 7-8 PM.*

ROANOKE, VA There will be WCARS/VEC Exams for upgrades only, beginning at 9 AM. Pre-register with *Fred L. Horton KZ4Y, (703) 366-6266* or *Ben Giavaden N4BG, Route 7, Roanoke VA 24022.*

SELAH, WA A Hamfest will be held by the Yakima ARC (W7AQ), at the Selah Middle School Gym from 8 AM-5 PM. Talk-in on 146.66, 444.800 and 146.52 simplex. The 2nd Northwest Packet Forum will be held at 9 AM. VE Exams at 10 AM. Potluck Picnic Sun. at Noon. Contact *KF7ZS, (509) 697-8080 (non fax),* or *N7HHU via packet at YKM.*

MAY 16

CAMBRIDGE, MA A Tailgate Electronics/Computer/Amateur Radio Flea Market will be held from 9 AM-2 PM at Albany & Main Sts. Talk-in on 146.52 and 449.725/ 444.725 pl 2A (W1XM) Rptr. Sponsored by the MIT Radio Soc. and the Harvard Wireless Club. Reservation deadline May 4th. Contact *(617) 253-3776.*

HAGERSTOWN, MD The 1993 Great Hagerstown Hamfest, sponsored by Antietam Radio Assn. (W3CWC), will be held from 8:30 AM-3:30 PM at Hagerstown Jr. College Athletic & Rec. Center. For reservations contact *Fred Bailey N3HTN, Hamfest Chairman, (301) 416-8079.* VE Exams may be given by the Mountain ARC-VEC; for info call *(304) 289-3576 or (301) 724-0674.* Talk-in on the Hagerstown 146.34/.94 Rptr.

OLD WESTBURY, NY The L.I. Mobile ARC will hold an outdoors Hamfest at the New York Inst. of Tech., Route 25A. VHF Tune-up Clinic. Talk-in on 146.25/.85. Contact *Neil Hartman WE2V, (516) 462-5549.*

WHEELING, WV The Triple States RAC will sponsor the 1993 TSRAC Wheeling Hamfest/Computer Show from 8 AM-3 PM at the White Palace, Wheeling Park. ATV demos. Seminars. Talk-in on 146.91. Contact *The Triple States RAC, Box 240, RD #1, Adena OH 43901. Tel. (614) 546-3930.*

MAY 20-22

RACINE, WI The Racine Hamfest and Big Boy's Toy Show, sponsored by Racine Megacycle Club (W9UDU), will be held in downtown Racine, On the Lake, Hwy. 20 East from I-94. Time: Fri. May 20th, 5 PM-9 PM; Sat. May 21st, 8 AM-7 PM; Sun. May 22nd, 8 AM-5 PM. Vendors call *Rory or Kelly, (414) 636-9271.* ARRL/VEC Exams Sat. 9 AM-11 AM. Talk-in on Lakeshore Rptr. 147.27.

MAY 21

ELIZABETHTON, TN Western Carolina AR Society/VEC, Inc. will sponsor VE Exams at Moody Aviation-Carter County Airport at 7 PM. Pre-registration only. Contact *Joe Hopkins K4BKI, (615) 543-4022* or *Jon Christiansen AB4NN, (615) 543-7155.*

MAY 21-22

SO. SIOUX CITY, NE The 3900 Club and the Sooland ARA will sponsor Hamboree 15 at the Marina Inn. Flea Market. Convention. Bus Tour. QCWA Luncheon. MARS, and more. Flea Market contact: *Al Smith W0PEX, 3529 Douglas, Sioux City IA 51104. Tel. (712) 258-7475.* Convention/Banquet contact: *Dick Pitner W0FZO, 2931 Pierce St., Sioux City IA 51104. Tel. (712) 258-1520.*

MAY 22

EPHRATA, PA Lancaster County Hamfest sponsored by the Ephrata Area Rptr. Soc., Inc., will be held at the Ephrata Sr. High School, 803 Oak Blvd., starting at 8 AM. VE Exams at 9 AM. Contact *Tom Youngberg K3RZF, (215) 267-2514 after 6 PM,* or write to *E.A.R.S., 906 Clearview Ave., Ephrata PA 17522.* Talk-in on 145.45 and 444.650 MHz.

GRAND RAPIDS, MI The Independent Rptr. Assn. will hold its 13th Annual Hamfest at Wyoming Nat'l Guard Armory, 44th St.; 1/2 mile west of the 131 x-way. Hours: 8 AM-4 PM. Talk-in on 147.160 Link System. Contact *Tom or Kathy Werkema KA8YSM/KB8KZH, (616) 698-6627.*

MINNEAPOLIS, MN There will be a Tailgate Swapfest from 7 AM-2 PM at the Honeywell Ridgway plant parking lot, 2600 Ridgway Pkwy., Stinson Blvd. Contact *Bill Brisley N0BSN, 18025 Cynthia Dr., Minnetonka MN 55343. Tel. (612) 474-0118.* Sponsored by TwinsLAN ARC.

PADUCAH, KY Come to the Noble Park Civic Center to enjoy a Hamfest sponsored by the Paducah ARA. Time: 8 AM-2 PM. Talk-in on 147.06/.66. VE Exams. Contact *David Fraser KQ4IU, 5715 Blandville Rd., Paducah KY 42001. Tel. (502) 554-7999* or *Paul Smith N4FFO, 229 Nickello Hts., Paducah KY 42001. Tel. (502) 898-6834. Packet address @W4NJA.KY.USA.NA.*

MAY 23

CANFIELD, OH The Twenty over Nine Radio Club will hold its 9th Annual Computer/Electronic Hamfest from 8 AM-3 PM at the Canfield Fairgrounds on Fairgrounds Blvd. Flea Market. Talk-in on 147.315+, 443.225+ or 223.5 simplex. Contact *Don Stoddard, 42 South Whitney Ave., Youngstown OH 44509.*

MAY 28-30

EDMONTON, ALBERTA, CANADA Northern Alberta Hamfest 93, sponsored by the Northern Alberta RC, will be held at Shakers Acres RV Park, 21530 - 103 Ave. Contact *Jim Steene VE6JDS, 9319 - 95 St., Edmonton, Alberta T6C 3X1 Canada. Tel. (403) 469-2595.*

MAY 30

CHICAGO, IL The Chicago ARC Hamfest will be held from 8 AM-3 PM at DeVry Inst. of Tech., 3300 N. Campbell. Flea Market. Walk-in VE Exams by Great Lakes VEC. Talk-in on 147.255+ 107.2, 444.825+. For info call *(312) 666-1606* or *(312) 545-3622.* Make reservations with *CARC, c/o Dean Woodman NB9Z, 1501 Ashland, Evanston IL 60201-4001* or *W9CAF packet on 144.930.*

SOREL-TRACY, QUEBEC, CANADA "Hamfest du Quebec" will be held at the Curling Club located in Tracy. Contact *Club Radioamateur Sorel-Tracy Inc., Boite Postale 533, Sorel Quebec, J3P 5N6 Canada.*

WEST FRIENDSHIP, MD The Maryland FM Assn., Inc. will host its Memorial Day Hamfest at the Howard County Fairgrounds, Route #144, from 8 AM-3 PM. Flea Market tables by pre-registration only. Contact *Melvin Seyle WA3KZR, 15809 Pointer Ridge Dr., Bowie MD 20716. Tel. (301) 249-6147.* Talk-in on 146.16/.76, 223.16/224.76 and 449.0/444.0 WA3DZD Rptr.

JUNE 5

KITCHENER, ONT., CANADA The Central Ontario AR Fleamarket will be held at Bingeman Park. Contact *Jack Knight VE3RGY, 35 Brockville Ave., Guelph, Ont. Canada N1E 5X5. Tel. (519) 823-1358.*

KNOXVILLE, TN The RAC of Knoxville will present its 27th Annual Amateur Radio and Computer Fair at the Tenn. Valley Fair Grounds, 8 AM-4 PM. Talk-in on 147.300+, 224.500-. For VE Exams, contact *Rich Slover ND4F, (615) 539-4821.* Ticket/table contact: *Angela Crigger N4RPR, 2707 Pine Hill Dr., Knoxville TN 37932. Tel. (615) 694-9071.*

TEANECK, NJ The Bergen ARA will hold its annual Spring Hamfest from 8 AM-2 PM at Fairleigh Dickinson Univ. VEC Exams. Flea Market spaces by pre-registration only. Talk-in on 146.190/.790 and 145.620 simplex. For Hamfest info call *Jim Joyce K2ZO, (201) 664-6725.* Get VE info from *Pete Adely K2MHP, (201) 796-6622.* Please, no calls after 10 PM.

JUNE 6

BUTLER, PA The Breezeshooters of Western PA will sponsor their 39th Annual Computer/Hamfest from 8 AM-4 PM at the Butler Farm Showgrounds. Mobile Check-in on 28.495 and 146.520. Talk-in and directions available on 147.96/.36. Fly-in available at Roe Airport. Contact *Rey Whanger W3BIS, Box 8, R.D. 2, Cheswick PA 15024. Tel. (412) 828-9383.*

DAVISVILLE, NH The Contoocook Valley RC Ham Radio/Computer/Electronics Tail-Gate Flea Market will be held from 8 AM-3 PM. Talk-in on 146.895 K1BKE Rptr. Contact *John C. Moore, (603) 746-4817.*

QUEENS, NY The Hall of Science ARC Hamfest will be held at the New York Hall of Science parking lot, Flushing Meadow Park, 47-01 111th St., beginning at 9 AM. Talk-in on 444.200 WB2ZZO Rptr., or 146.52 simplex. Call evenings only: *Charles Becker WA2JUJ, (516) 694-3955* or *Arnie Schiffman WB2YXB, (718) 343-0172.*

SPECIAL EVENT STATIONS

MAY 1

MEMPHIS, TN The Mid-South ARA will operate W4EM 1500Z-2200Z to celebrate the Memphis in May Internat'l Festival in honor of Russia. Operation will be in the lower 50 kHz of the SSB General 40m-12m, and the Novice 10m subbands. AMTOR frequencies: 21.080, 14.100, 7.080 and 3.580 MHz +/- QRM. For a certificate, send QSL and a 9" x 12" SASE to *MARA-W4EM, c/o Pat Lane, 3390 Northwood Dr., Memphis TN 38111.*

SPRINGFIELD, IL The Sangamon Valley RC will operate W9DUA 1400Z May 1-2200Z May 2, to commemorate the 5th anniversary of the dedication of the Illinois Vietnam Veterans Memorial at Oak Ridge Cemetery. Operation will be in the General portions of the 160m thru 15m bands to include the Novice 10m subband. For a special QSL card, send a letter size SASE to *W9DUA SPL EV, San-gamon Valley Radio Club, Red Cross Bldg., 1025 S. 6th, Springfield IL 62707.*

MAY 1-JUNE 30

VICTORIA, BC, CANADA The Friendship ARS of Victoria will celebrate the 1993 Friendship Radiosport Games and Hamfest by operating XO7G daily at 2100Z-0500Z in the General class sub-bands. QSI direct or by bureau. For details, contact *FARS-Victoria, c/o Camosun College Box 128, 3100 Foul Bay Rd., Victoria BC, V8P 5J2 Canada.* Visitors may operate a Field-Day SE Station June 26th & 27th.

MAY 6-7

KAYSVILLE, UT The Davis High School ARC will operate KG7TE 1600Z-2200Z to celebrate the beginning of summer vacation. CW: 14.050, 21.050, 28.050; Phone: 7.285, 14.285, 21.285, 28.375, 145.59. For a certificate, send SASE to *Sara Otterson KB7OTZ, 1549 N. Honeybee Circle, Farmington UT 84025.*

MAY 8

CARTHAGE, TX Carthage AR Service, Inc., will operate N5IKS 1400Z-2100Z from the Tex Ritter Museum, near the middle of the 40, 20 and 15m General level and 10m Novice bands. For a certificate, send your contact number, QSL card and business size SASE to *N5IKB, 221 Browning St., Carthage TX 75633.*

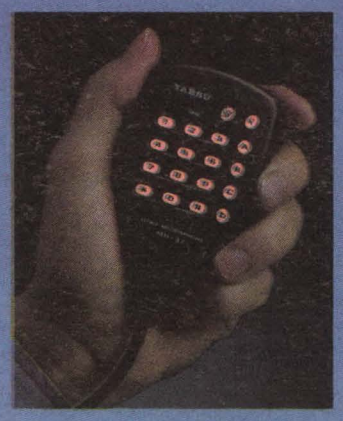
RF

FT-2400 Military Spec'd TOUGH

NOTHING COMPARES...

Whether you're roughing it on the tortuous dirt roads of the Baja 1000 or through the big city canyons, the ruggedly designed FT-2400 is built to take the abuse. In fact, the FT-2400 is the first and only amateur radio to be awarded a MIL-STD-810 rating for the shock and vibration. That's why Yaesu is the official radio of the Nissan off-road race teams.

Exceptional features are packed into the FT-2400 such as: ■ **LCD Display—the largest display available on any 2 meter mobile** ■ **Alpha Numeric—for entering names or callsigns** ■ **Backlit DTMF Microphone—for making autopatch calls safely at night** ■ **31 Memories** ■ **Odd Splits—on any memory channel** ■ **3 Selectable Power Level Outputs—50, 25 and 5 watts or user select** ■ **Advance Track Tuning (ATT)—eliminates big city intermod** ■ **Automatic Display Dimmer—4 levels** ■ **FM Modulation—for true voice clarity** ■ **DTMF Selective Paging (optional).**



Other features include: Wideband receiver coverage 140-174 MHz RX, 140-150 MHz TX • CTCSS encode built-in and selectable from the front panel • Five scanning functions: Band Scan, Limited Band Scan, Memory Scan, Memory Channel Lock-out with Selectable Scan Stops and Priority Scans • One piece die-cast construction with extra large heat sink • Automatic Repeater offset • Programmable call channel.

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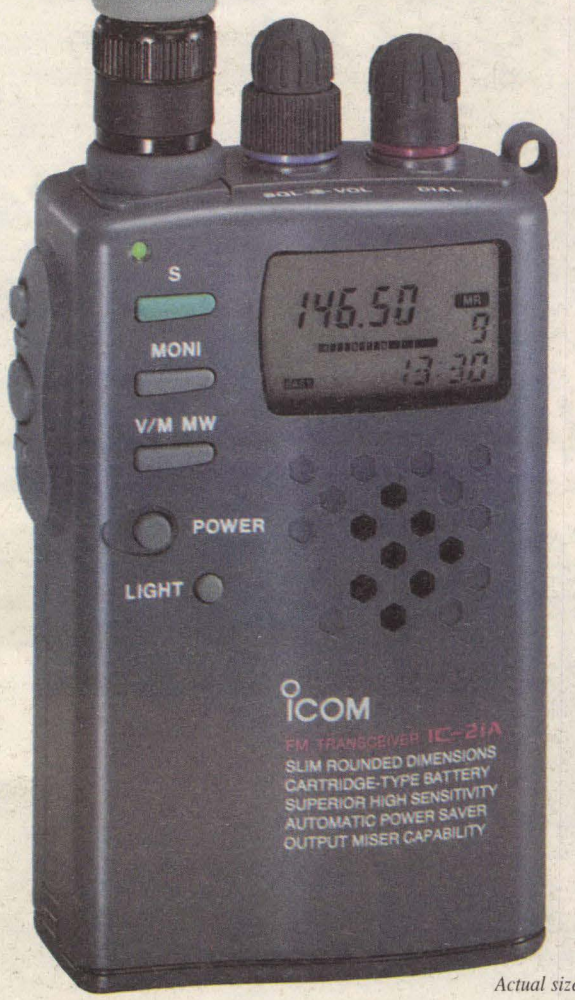

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SAT Series
2SAT - 2M
3SAT - 220MHz
4SAT - 440MHz

GAT Series
2GAT - 144MHz
4GAT - 440MHz
12GAT - 1.2GHz

0AT Series
02AT - 2M
03AT - 220MHz

Dual Band
W2A - 2M/440MHz
W21 - 2M/440MHz
X2A - 440MHz/1.2GHz
24AT - 2M/440MHz

AT Series
2AT - 144MHz

ICOM America, Inc., 2380 116th Ave. N.E., Bellevue, WA 98004 All stated specifications subject to change without notice or obligations. All ICOM radios significantly exceed FCC regulations limiting spurious emissions. 2iA1192

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